JUN 12 1939

ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JUNE 8, 1939

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Annual Waterworks Number

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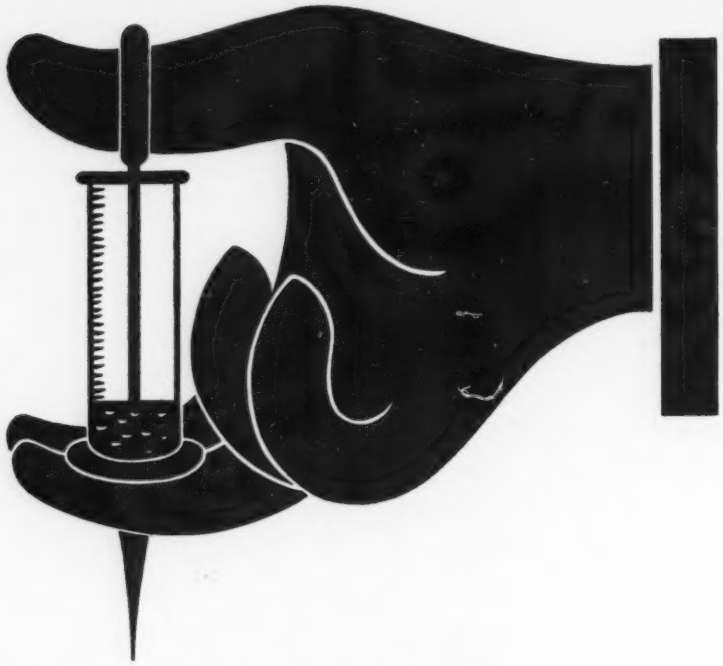

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THIS WEEK

THE MAJOR ELEMENT of this issue is the Waterworks section, which is directed to the men who will assemble at Atlantic City next week for the annual convention of the American Water Works Association. In concise form it brings together a wide variety of up-to-date information that should be of interest to many men outside the sanitary engineering field.

● But the issue is not given over exclusively to waterworks matters. The lead article tells of construction at Possum Kingdom Dam, one of the most talked of dams among experts today because of its unusual foundation conditions and the fact that it is the first massive-buttress and slab-deck type of dam built in the country. There also are two articles on how railway and highway engineers protect slopes, two on building operations, one on a method of protecting concrete against the action of salt water and a working article on curve centering for railroad engineers who have to make tracks safe for high-speed trains.

THINGS TO COME

BUILDING a $1,800,000 factory in eleven weeks, or less time than it usually takes to build an ordinary house is an accomplishment to which the construction industry—its engineers, contractors and manufacturers—can point with pride. It was done for the Glenn L. Martin Co., airplane manufacturers of Baltimore and the story will be told in the June 22 issue.

SOMETHING new and different in the way of earth-moving equipment and methods have appeared in the construction of Hansen Dam, the world's largest dry-earth embankment, now being built in Tujunga Wash near Los Angeles. A description of the 13,000,000-yd. dam and two new types of earth movers will appear in two articles to be published soon.

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ENGINEERING NEWS-RECORD

Volume 122 JUNE 8, 1939 Number 23

More Federal Help For Roads Planned

Bill being drawn to help states get land for express routes into the large cities

Legislation is in preparation in Senator Hayden's office which will implement certain of the suggestions made in the recent report on super-highways prepared by the U.S. Bureau of Public Roads. The bill will involve federal assistance to the states in the acquisition of rights-of-way for major highways.

The chief present need, according to the U.S.B.P.R. report, is for express routes through, into, and out of large cities. It is felt that the major deterrent to construction of such routes is the cost of land. If the federal government offers aid in this respect, the actual cost of construction, it is believed, will not form an important obstacle—especially if sufficient land is acquired so that the highways could be depressed.

No federal construction of highways is included in Senator Hayden's proposals. Neither does the Senator contemplate any program of excess land condemnation (for later resale after its value had been increased by the highway) such as was mentioned in the U.S.B.P.R. report; the report itself raised a question as to the constitutionality of such action. The bill, however, probably will so define "right-of-way" as to permit purchase of land for marginal parks and landscaping.

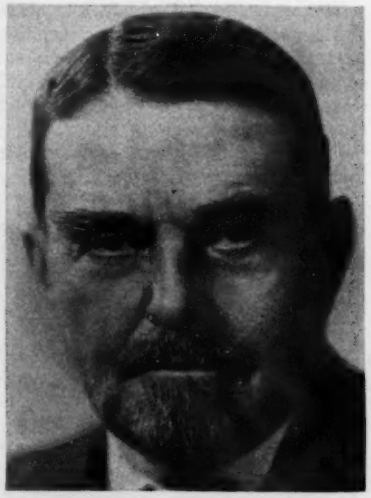
Senator Hayden's office hopes to get the bill into shape for introduction during this session of Congress, but legislative action on it will doubtless have to wait until next session.

• • •

Parker Dam Lake Gets New Name

Havasu Lake has been adopted by the Department of the Interior's Board of Geographic Names as the official designation of the lake created by Parker Dam on the Colorado River, 165 miles below Boulder Dam. The lake is the pool from which water is drawn for the Colorado Aqueduct.

The word "Havasu" in the Mojave Indian language means "blue". The name was first given to the lake by a Mojave chief who was surprised to see the coffee-colored Colorado River forming a clear blue lake.



Fred Llewellyn Retires From U. S. Steel

Retirement June 1, of F. T. Llewellyn from his post as research engineer of the United States Steel Corp. was the signal for numerous technical organizations and individuals to pay their respects to one of the outstanding members of the profession. From the time he began his structural engineering career in Minneapolis in 1890 to the present day, Fred Llewellyn has continuously made new friends and new contributions to engineering knowledge. Widely known in recent years for his part in bringing about the standardization of structural shapes and for his work in behalf of structural welding research and development, he has always been an outstanding practitioner in the field of civil engineering.

In the late Nineties, Llewellyn su-

(*Continued on p.* 63)

Concreting Ends At San Jacinto

Colorado Aqueduct near completion as lining of the last of 38 tunnels is finished

The last tunnel in the 392-mile Colorado River Aqueduct was completed May 30 when placing of concrete lining in the 13-mile San Jacinto tunnel was finished. San Jacinto, the last to be completed of 38 tunnels with a total length of 108 miles, was one of the most difficult jobs in connection with the construction of the aqueduct. Excavation of the bore was completed last November.

It will still be several months before the tunnel is ready to carry water, since a large amount of clean-up work remains to be done, including removal of 13 miles of railroad track as well as water and airlines, electrical conduits, and other construction utilities. The only uncompleted link in the aqueduct, a 700-ft. siphon at the west portal of the San Jacinto tunnel, is expected to be completed by the time the clean-up work is finished in San Jacinto. At that time the entire metropolitan aqueduct will be ready to carry water from the Colorado River back of Parker Dam to the Cajalco Reservoir on the coastal plain, whence it will be distributed to San Francisco and 12 other Southern California cities. The aqueduct will have an ultimate capacity of 1,000 mgd.

• • •

Ohio Authority to Build State Hospitals

Creation of an institutional building authority in Ohio authorized to issue $7,500,000 in revenue bonds is approved in a bill which has been signed by Governor Bricker. The bonds will be used to build new state hospitals and improve existing hospitals and will be liquidated from revenues derived from the care of patients.

A test case is expected to be brought soon in Ohio Supreme Court to determine the legality of the plan.

Pavement Engineering Attacked in Chicago

City Club charges inadequate specifications and poor construction on WPA-paved streets

Investigation of sheet asphalt paving by the City Club of Chicago, begun two years ago, is reported in a 25,000-word mimeograph booklet. Under the title "Defective Sheet Asphalt Pavements in Chicago" the report has special reference to 1935-37 WPA resurfacing projects for which $50,000,000 has been paid out on 300 mi. of streets.

Characteristic defects noted are waviness, cracking, pushing under traffic, honeycombing, disintegration (some replacements already have taken place) potholes and depressions. Causes listed are as follows: Non-uniform mixtures due to faulty proportioning of ingredients that may produce too hard or too soft pavements; burning of mixtures in the plant resulting in lack of ductility and brittle pavement; resurfacing in subfreezing weather, leading to porous topping which absorbs water, freezes and crumbles; inadequate compaction due to too light a roller; failure to use a straightedge for testing surface evenness; poor bond between the intermediate and surface course; broken and unsuitable base for resurfacing.

Inadequate specifications and poor technique are claimed in the report to be at the bottom of the difficulty. It is stated that (1) city and park district specifications were unnecessarily restrictive in some respects and woefully inadequate in others, and (2) faulty paving technique and obsolescent equipment were used. While more than $100,000 was spent in tests, they are described as mere identification tests of constituent materials rather than quality tests of the ingredients and of the finished asphalt paving mixtures. No stability tests were made of topping mixtures as produced at the plants or as laid after rolling.

The investigation was made and the report prepared by A. W. King, chemical engineer engaged for the purpose by the executive committee of the club.

• • •

Spokane River Bridge Wrecked by Truck

An old steel and timber Howe truss bridge, 200 ft. long, across the Spokane River on Washington state highway No. 22 between Fruitland and Davenport collapsed May 23, five days after it had been struck by a runaway oil truck. The tank car, a trailer, broke its couplings and backed down onto the bridge, hitting and destroying one of the batter posts at the end of the span.

After a five day effort to repair the structure, state highway workmen allowed the bridge to settle into the river. A temporary bridge will be erected soon, but no permanent replacement will be made as the bridge will ultimately be flooded out by backwater from Grand Coulee Dam.

• • •

Fifty-Yr. Old Kansas Bridge Fails Under Heavy Load

A 300-ft. iron bridge with a wooden floor, across the Republican River at Junction City, Kan., collapsed May 28 under the weight of a truck and trailer weighing about 26 tons. The bridge, which was built in 1887, was posted for 7-ton loads. The driver of the truck was killed.

The bridge was only 14 ft. 9 in. wide, and the collapse occurred when a motor car tried to pass the truck near the center of the bridge; the truck load was 10 ft. wide, and when the truck crowded to the edge of the roadway the bridge buckled and dropped into the bed of the river.

Big Contracts Let On South Penn Highway

The Pennsylvania Turnpike Commission late last month awarded contracts totaling $4,812,000 for 11.2 miles of the South Penn Highway, the toll road between Pittsburgh and Harrisburg along the roadbed of the old South Penn Ry. which the commission is building with the aid of PWA and RFC funds.

Two contracts were awarded for tunnel excavation. Mason & Hanger, Inc. of New York City were awarded a $1,550,000 contract for construction of the Rays Hill Tunnel and approaches, and B. Perini & Sons of Framingham, Mass., offered a successful bid of $2,056,000 for construction of the Tuscarora Tunnel and approaches.

A $710,000 contract covering 6½ miles of grading and drainage was awarded to Guthrie-Marsh-Peterson Co. of Chicago, and a $497,000 contract was awarded to M. Bennett & Sons of Indiana, Pa., for construction of a steel viaduct about 500 ft. long over the Raystown branch of the Juniata River at Dunnings Creek and two underpasses and a drainage structure.

Bureau of Reclamation photo

RAILROAD RELOCATIONS AT SHASTA DAM

RAILROAD LINES will do some moving in the next few years at Shasta Dam where these two relocations are being built for the same railway line. The main line railroad which now runs up the Sacramento River canyon across the site of Shasta Dam, will be rerouted early this summer through the bypass tunnel which has been driven through the west abutment of the damsite. About two years later trains will again be rerouted over a 30-mile relocation above reservoir level, of which the Sacramento River bridge at Redding, Calif., shown above, will form a part.

Concrete lining 18 to 21 in. thick is being placed in the horseshoe-shaped tunnel, 1,820 ft. long, 28 ft. high, and 26 ft. wide. After the trains stop using the tunnel, it will be used for river diversion during the dam construction.

The Sacramento River bridge, four-fifths of a mile long, will require erection of 6,000 tons of structural steel on 152 concrete piers. It is one of eight large bridges included in the relocation.

Senate Maintains Big River Fund

Approves House amendments adding $50,000,000 to rivers and harbors and flood control money

Addition of $25,000,000 each to budget estimates for river and harbor construction and for flood control by the House last month (*ENR*, May 18, 1939, p. 683) was confirmed in the Senate on June 1. The Senate committee on appropriations had recommended a return to the original budget figures of $71,000,000 for rivers and harbors, $110,000,000 for general flood control, and $37,000,000 for flood control on the Mississippi. The Senate however held to the House figures of $96,000,000, $133,000,000 and $39,000,000 respectively. Because a number of minor amendments were added, the bill now goes back to the House.

During the debate on the bill, Majority Leader Barkley announced he had been assured that the President would allocate $50,000,000 from relief funds to river and harbor and flood control work; Barkley urged therefore that the budget figures be adhered to, but some speakers felt the work should not be done under release rules.

• • •

Bill Introduced to Change Boulder Dam Power Rate

A bill changing the basis of computation of rates for power generated at Boulder Dam was introduced into the House June 2 by Representative Scrugham.

The bill, which will supersede provisions of the Boulder Canyon Project Act directs the Secretary of the Interior to set rates for power which will meet operation and depreciation charges, cover certain special payments, and repay with interest within 50 years the cost of the dam, exclusive of the $25,000,000 allocated to flood control. The Scrugham Bill would reduce the 4 per cent interest rate now employed in computing the repayments to 3 per cent and would require that interest during construction of the project be computed at the rate actually paid by the government for money it borrowed.

The bill provides that the $25,000,000 allocated to flood control be repaid without interest after the other repayable charges have been amortized.

The special funds which must be met are payments of $300,000 annually to Arizona and to Nevada, in place of the percentage which these states now receive, and an annual payment of $500,000 to be devoted to developments of the Colorado River.

Winchester, Mass., Chosen For Planning Experiment

Capital outlays for municipal improvements scheduled on a 6-year pay-as-you-go program have been accepted by the town of Winchester, Mass., in a pioneer movement to plan public works on a more efficient basis. Last April representatives of the Public Works Committee of the National Resources Committee conferred with the Winchester Planning Board and other town officers with a view toward setting up such a program. Projects were submitted by the town departments and allocated over the period according to a priority grouping tentatively determined by the planning board. Estimates were then made of the future revenues of the town for the period.

Winchester was selected for the study on account of its excellent methods of municipal procedure and its complete records. The planning board states that this is the first of a group of municipalities where similar studies will be made.

The local work has been done without expense to the town under general direction of W. Stanley Parker, Boston architect, a member of the Public Works Commission; by a staff headed by Melvin F. Scheidt, research technician of the National Resources Committee, assisted by Sidney T. Thomas and Morgan D. Hayes of the PWA and Frank W. Blanchette of the WPA.

The planned program is based on estimated annual revenues ranging from $1,269,946 in 1939 to $1,385,571 in 1944, with a tax rate set at $29.20 for each year. Estimated amounts available for capital improvements vary from year to year, beginning with $247,996 in 1939 and ending with $209,049 in 1944.

• • •

Fred Llewellyn Retires

(*Continued from p. 61*)

pervised the design of the St. Charles Hotel in New Orleans, first steel skeleton building in that city, later erecting bridges and buildings in the South and in Mexico. Coming to the American Bridge Co. as contract manager in St. Louis in 1900, he later transferred to a similar position in New York. From 1906 to 1917 he was with Carnegie Steel Co. and devoted his attention to the development of new products, an activity which he continued from 1919 to date while attached to the office of the president of the U. S. Steel Corp.

The American Institute of Steel Construction passed a resolution last week expressing appreciation to Llewellyn for his assistance over many years and particularly for serving as chairman of its committee on manual and specifications.

Grand Coulee Breaks Concreting Record

Consolidated Builders exceed M. W. A. K.'s 1937 24-hour record, placing 20,684 cu.yd.

The concrete mixing plant operated by Consolidated Builders, Inc., at Grand Coulee Dam on May 25 broke the record established in 1937 by M.W.A.K., the low dam contractors, by placing 20,684 cu.yd. of concrete in a 24-hour period. The previous record was 15,844 cu.yd.

Two concrete plants are operated at the Grand Coulee damsite, each consisting of four 4-yard mixers. Placed on opposite sides of the river during construction of the low dam, the two plants are now under one roof.

More than 1,500,000 cu.yd. of concrete have been placed under the high dam contract since Feb. 2, 1938, and the contract calls for 4,500,000 cu. yd. more. Construction of the low dam, between 1934 and 1938 required placement of 4,500,000 cu. yd.

Cement shortage felt

Since establishing its record, Consolidated Builders has had to cut down its rate of concrete production because the cement mills supplying the dam are unable to supply the demand at the necessary rate. The present cement contract calls for delivery of 320,000 bbl. per month, but the mills have been delivering 365,000 bbl. It is understood that the contractor and the Bureau of Reclamation have requested delivery of 450,000 bbl. a month but that the mills were unable to supply this.

Bids to supply 3,500,000 bbl. of low-heat cement and 152,000 bbl. of modified cement, enough to complete the dam, will be opened by the Procurement Division of the Treasury in Washington June 9, having been postponed from June 1. The present contracts expire this summer.

• • •

Long Suspension Bridge Completed in Rhodesia

One of the longest suspension spans outside of this country, the 1,050-ft. Beit Bridge over the Zambezi River at Chirundu, Southern Rhodesia, was completed late last month.

In addition to the suspension span, the bridge includes four 40-ft. approach spans. The main span is supported by two 8-in. steel cables anchored in rock on each side of the river.

The bridge was built by Dorman Long & Co. of England.

OBITUARY

FRED S. NAIDEN, 52, city engineer of Marshalltown, Ia., since 1931, died May 25. Following his graduation from Iowa State College in 1909 he went into construction work, and later was county engineer of Dallas County, Iowa.

JOHN F. BLYTHE, Charlotte, N. C. contractor, died May 30. He had been a partner of W. I. Isenhour since 1908.

JOHN D. BROWN, engineer of bituminous research for the Michigan State Highway Department, died in Ann Arbor May 31 at the age of 42. He had graduated from the University of Michigan in 1922, and joined the highway department in 1934.

VICTOR HUGH GARVEY, 53, an assistant in the Chicago, Milwaukee, St. Paul & Pacific Railroad engineering department at Seattle, died there May 26. He was a graduate of the University of Washington College of Engineering and served during the World War as a captain of the 23rd Engineers.

JOHN FREDERICK BEALS, 73, civil engineer of Tacoma, Wash., died there May 26. He had laid out the town of Ruston, near Tacoma, and helped design the Tacoma stadium.

EARL A. ROBERTS, Seattle architect, died there May 28 at the age of 53.

CHARLES C. CAWSEY, Seattle general contractor, died there May 30 at the age of 73.

H. L. BAKER, 68, former civil engineer, died May 26 at his home near Bentonville, Ark.

FRANK WILCOX, 85, retired New York and Pittsburgh engineer, died May 25 in Columbus, Ohio. He was a graduate of Stevens Institute of Technology, Hoboken, N. J.

CHARLES ANDREW MAURY, retired hydraulics engineer of Seattle, died there May 22.

EDWARD F. DRAKE, 77, a former director of the Dominion Reclamation Service, died recently in Ottawa. He was an expert in the investigatory features of water resources work.

WILLIAM H. DITTOE, 53, chief engineer and secretary of the Mahoning Valley Sanitary District since 1926, died May 27 in Youngstown, O. After having been with the Ohio department of health from 1908 to 1926, during most of which time he was chief engineer, he joined the Mahoning District as chief engineer at the time of its organization. It was under his direction that the $9,000,000 Meander water supply was built.

ARTHUR JABEZ VANNOSTRAND, land surveyor, died in Richmond Hill, Ont., May 23 at the age of 77. He was an honorary member of the Canadian Institute of Surveyors.

• • •

Wyoming Road Body Drops District Offices

In a sweeping reorganization expected to save about $200,000, the five district offices of the Wyoming highway department were abolished June 1, and activities of the department will be directed in the future from state headquarters at Cheyenne. There were formerly district offices at Cheyenne, Casper, Sheridan, Basin, and Rock Springs.

Talcott Moore and J. G. Smith, district engineers at Cheyenne and Rock Springs respectively, have been made state construction engineers with headquarters at Cheyenne. R. J. Templeton, district engineer at Sheridan, has been made maintenance engineer for the state, and Herman Langheldt, formerly maintenance foreman at Casper, becomes his assistant.

The status of W. B. Schilling and J. R. Phillips, district engineers at Casper and Basin, was not announced.

Wide World Photos

TWO BUILDINGS SUFFER IN GAS EXPLOSIONS

AT POINTS as widely separated as New York City and Barberton, Ohio, gas explosions last week took a toll of structural damage and personal injuries. At Barberton, a gas explosion of undetermined origin wrecked a two-story frame house being used temporarily as a school building, injuring 59 children and adults, four of them possibly fatally. The blast occurred when the janitor started to burn wastepaper in the basement. Investigations have been started by the director of industrial relations of Ohio and the U. S. Bureau of Mines.

In New York, the wall of an apartment in Knickerbocker Village, a multiple dwelling development in Manhattan, was blown out after a tenant had committed suicide by gas.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

EARLY REQUEST for bids for construction of the Friant Dam of the Central Valley project in California is expected as a result of completion June 5 of a contract by which the Bureau of Reclamation acquires the damsite from the Madeira irrigation district. The district receives $300,000 for the land and a nearby gravel deposit. With the site in its possession, the bureau hopes to advertise for bids before the end of the month.

IN ORDER to expedite completion of the recently negotiated sale of part of the Tennessee Electric Power Co. to TVA, the Senate on June 1 passed a measure, in the form of a rider to a technical financing bill, authorizing TVA to utilize its $100,000,000 bond-issuing authority for the purchase of generating facilities instead of only for construction and for purchase of transmission lines. The Senate had previously passed the same measure in the form of a separate bill, but that bill is held up in committee in the House. The purchase agreement will expire June 20 unless Congress takes action, and the present move will force an immediate vote in the House.

Fearing that Congress may fail to act in time to validate the TVA-Tennessee Electric Power Co. agreement, representatives of the interested parties, it is understood, are conferring with a view to arranging a 60 or 90 day extension of the agreement.

• • •

Federal Aid Jeopardized In Arkansas

Status of federal aid payments to the state of Arkansas has been cast in some doubt pending an investigation of whether certain WPA highway projects in the state constitute construction or maintenance. Arkansas has been profiting by a provision of the 1938 Federal Aid Act permitting payment of federal aid to states without matching if the state has no money available for road construction. A question has been raised because certain WPA road projects, to which the state is making a sponsor's contribution, are classified as construction, indicating that the state has money to match federal aid funds.

As a result of this situation, the state highway commission has ordered discontinuance of all WPA projects on the state highway system with the exception of projects carried on by others with the use of highway department equipment. Six highway improvement contracts totaling $160,000 have also been held up until the federal aid situation is clarified.

• • •

New Beach Improvement Completed in New York

Two miles of oceanfront within the city limits of New York were officially dedicated to public use June 3 when Robert Moses, sole member of the New York City Parkway Authority, opened the Rockaway Beach Improvement, located on the Atlantic Ocean beyond Jamaica Bay in the Borough of Queens. This improvement is part of the outer beach program which Moses is sponsoring.

The project provides the Rockaways with parkway approaches, widened thoroughfares, a modern traffic separator at the southern end of the highway across Jamaica Bay, two miles of oceanfront drive, and numerous play and park areas bordering the beach. More than 700 buildings were cleared away. Construction work cost $5,100,000, land acquisition $4,600,000, and overhead, contingencies, etc., $500,000.

Moses announced that, coincident with the opening of the Rockaway development, tolls on the Marine Parkway Bridge spanning Rockaway Inlet will be reduced to 10 cents. The same rate will prevail on the new Cross Bay Bridge.

• • •

A. J. McPhail Retires From Queens University

A. J. McPhail is retiring at the end of the current semester from the chair of general engineering and the chairmanship of the department of civil engineering at Queens University, Kingston, Ont., Canada. The university has just bestowed the honorary degree of doctor of laws upon him.

McPhail, known to engineers all over Canada as "Sandy" McPhail, was born in 1870 and graduated in engineering from McGill University in 1893.

After study in Europe and practice in Eastern Canada and the United States, he joined the staff of Queens University in 1904. Except for war service from 1914 to 1918 as officer commanding the first division engineers of the Canadian Expeditionary Force, McPhail has been at Queens ever since.

In addition to his engineering work, McPhail had for many years been an editor of *Queens Quarterly*, a Canadian literary publication.

Sanitary Threat Seen In Calumet Work

Pollution danger emphasized at Army hearing on Chicago river and harbor project

Consideration of the sanitary effect of dredging work in the Calumet industrial area equally with the needs of navigation was urged by Chicago officials at a War Department hearing held in Chicago June 2 to consider improvements to Indiana Harbor and the Little Calumet River. Chicago and Illinois officials testified that the $25,900,000 dredging project, if carried out in accordance with the plan of the Chief of Engineers (House Document 145) would change hydraulic conditions and increase the discharge of sewage from Indiana cities into the lower end of Lake Michigan, seriously endangering lake water supplies.

Officials testifying including Langdon Pearse of the Chicago Sanitary District; Arthur Gorman, engineer of water purification, Chicago Department of Public Works; J. I. Connolly, Chicago Board of Health; and Carter Jenkins, Illinois Division of Waterways.

Construction of control works near the lake outlet of the Calumet River and Indiana Harbor to prevent storm flow reversals was urged by these witnesses, and they suggested that no work be done until the Indiana cities put disposal systems in operation; changed hydraulic conditions will necessarily cause a greater lake diversion than at present and this will decrease the amount of lake water which can be diverted at the mouth of the Chicago River. The total annual diversion at that point was cut on Jan. 1 from 5,000 to 1,500 cfs. and the condition of the river and main channel has become increasingly foul.

• • •

Oklahoma Planning Board Hit by Shake-up

The heads of two divisions in the Oklahoma Planning and Resources Board have been replaced and 22 employees of the board have been dismissed under a reorganization carried out June 1. F. L. Vaughan, director of the water resources division, has been replaced by Don McBridge, formerly chief engineer of the division. Glen R. Durrell, head of the forestry division, replaced A. R. Reeves as head of the park division. The position of head of the planning division, now held by Tom Gammi, will be eliminated from the board staff July 1.

Radio Program Marks New Edition of U. S. Map

Completion of the latest edition of the official master map of the United States issued by the General Land Office was signalized by a one-hour radio program of the National Broadcasting Company at 2 p.m., Eastern Standard Time, Sunday, June 4. The magazine *Life* also devoted a major article to the new map in its issue which came out June 2.

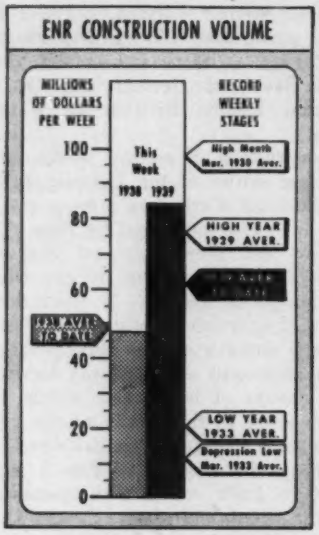
The only government publication portraying the rectangular survey pattern in use in the western states since 1785, the new master map, 7 ft. long and 5 ft. high, may be obtained for $2 each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $84,640,000, the fourth highest of the year and are 79 per cent higher than in the corresponding 1938 week.

The volume for 1939 to date totals $1,419,356,000, an increase of 26 per cent over the $1,124,552,000 reported for the initial 23-week period a year ago.

Private awards for the week are 102 per cent higher than in the 1938 week due to the large industrial building volume. Public construction is 73 per cent above a year ago. High earthwork and drainage, public building and bridge totals are responsible for the gain.



Earthwork and drainage volume reached its highest level since July 27 as a result of the beginning of work on the TVA Gilbertsville Dam project in Kentucky. An $11,300,000 power station project in New Jersey, and four bridge projects in New York, Maryland and Ohio totalling $5,275,000, bring industrial buildings and bridges to their second highest weekly volumes of the year. In addition to these three classes of construction, waterworks, public buildings and unclassified top their respective totals for the 1938 week. All construction groups exceed their volumes for the short preceding week.

New capital for construction purposes for the week totals $18,609,000, a decrease of 73 per cent from the volume for the 1938 week. The current week's total is made up of $13,428,000 in state and municipal bonds, $3,000,000 in corporate security issues, and $2,181,000 in RFC loans for municipal improvements.

Tables on p. 59.

LABOR NOTES

HEARINGS have been called for June 19 by Administrator Andrews of the Wage and Hour Division, U. S. Department of Labor, on requests for exemption, as seasonal industries, from the hours provisions of the Fair Labor Standards Act of certain types of surface mining. This would include quarrying of dimension stone and crushed stone and dredging and excavation of sand and gravel.

ELECTRICIANS in Columbus, Ohio, went on strike June 2 demanding a 25c an hour wage increase. Most of the major building projects in Columbus have been affected.

THE PENNSYLVANIA Federation of Labor has brought suit in an attempt to enforce abrogated closed shop contracts on the South Penn toll road project. They also want the independent group which has been organized on the project enjoined from interfering with AFL members, and they threaten, unless they receive a favorable decision, to call a general strike on PWA work in Pennsylvania.

TEN PER CENT salary cuts for all engineering personnel earning more than $200 per month are provided for in the 1939-40 budget of the Arizona highway commission. The salary committee of the Arizona section, Am.Soc. C.E., and the Phoenix chapter of the American Association of Engineers are considering filing a protest, but no action has yet been taken.

A BUILDING TIEUP is threatened by a strike vote of carpenters and laborers in Washington, D. C. Laborers want a 10¢ an hour increase, and carpenters want a dollar a day more and an hour a day less.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN MAY, 1939

Engineering News-Record *reports projects of the following minimum costs: — waterworks, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States May 1939	United States Five Months 1939	United States Five Months 1938	Canada
Public Works										
Waterworks	616	892	891	3,917	633	356	7,305	104,756	44,074	259
Sewerage	1,851	3,160	319	5,646	1,970	466	13,412	80,797	41,380	132
Bridges, public	586	5,678	481	909	1,707	985	10,346	69,068	34,091	250
Earthwork and waterways	97	973	1,409	698	2,898	4,652	10,727	64,589	95,474	447
Streets and roads	1,364	18,304	10,716	11,808	11,988	3,517	57,697	270,659	185,107	611
Buildings, public	598	29,921	16,700	13,207	10,157	4,731	75,314	302,039	147,361	165
Unclassified, public	1,849	3,640	3,809	1,792	2,803	826	14,711	73,282	46,035	296
Total public	**6,961**	**62,568**	**34,317**	**37,977**	**32,156**	**15,533**	**189,512**	**965,190**	**593,522**	**2,160**
Federal government (included in above classifications)	39	11,929	2,844	2,130	3,603	8,273	28,908	103,283	98,381	.....
Private										
Bridges, private	175	71	.....	.....	.....	.....	246	2,311	4,249	.....
Buildings, industrial	1,454	4,035	5,543	1,235	2,342	4,114	18,723	73,215	79,514	6,087
Buildings, commercial	1,905	16,039	2,596	1,818	1,339	755	24,452	163,994	312,103	1,039
Unclassified, private	150	403	1,610	8,621	8,921	354	20,059	90,119	42,477	226
Total private	**3,684**	**20,548**	**9,749**	**11,674**	**12,602**	**5,223**	**63,480**	**329,639**	**438,343**	**7,352**
Total Engineering Construction										
May, 1939 (4 weeks)	**10,645**	**83,116**	**44,066**	**49,651**	**44,758**	**20,756**	**252,992**	.....	.....	**9,512**
April, 1939 (4 weeks)	12,436	82,084	33,838	54,322	40,673	17,382	240,735	.....	.....	5,666
May, 1938 (4 weeks)	11,538	83,356	18,142	22,486	27,531	20,753	183,806	.....	.....	5,000
Five Months — 1939	74,981	428,502	192,213	240,790	239,783	118,560	.....	1,294,829	.....	.....
Five Months — 1938	46,179	471,512	97,699	119,958	167,778	128,739	.....	.....	1,031,865	28,333

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Bolted Timber Joints

Sir: Since the article entitled "Strength of Bolted Timber Joints" appeared in *Engineering News-Record*, May 11, 1939, p. 661, some questions have been raised in regard to the statement on area requirements which at times is over-conservative. The requirements given in paragraph 3, p. 662, for bolts bearing parallel to the grain (that the total bearing area should not exceed 55 per cent of the cross-sectional area of the member for coniferous woods and 50 per cent for hardwoods) apply when all the bolts are placed in one cross-sectional plane or are staggered. If, however, the bolts are spaced longitudinally in rows along the member, the net tension area remaining at the critical section should be at least 80 per cent of the total area in bearing under all the bolts when coniferous woods are used, and equal to the bearing area under all the bolts when hardwoods are used.

W. W. WEBER
U. S. Forest Products Laboratory
Madison, Wis.

More Light on Fort Peck

Sir: In your issue of May 11, p. 53, you published an editorial on Fort Peck under the title "More Light Needed". *Engineering News-Record* could, itself, have contributed additional light by publishing the full text of the report of the board of consultants.

In your opening paragraph, you state "The investigating board in its report *published in this issue* fails to give such guidance". In spite of this editorial statement you have printed only a part of the report. The report consisted of nine sections with a preamble summarizing the investigations and studies. Of this you reproduced only sections 1 and 4 and the major part of Section 2. The report itself is only six typed pages long and it would seem, considering the importance of the matter, that you might have afforded the space to print the complete report.

One section of the report which you omitted was Section 9 which reads as follows:

> Compilation of data—The board recommends that the district engineer assemble and correlate in permanent form all data pertaining to the mode of occurrence of the slide, the investigation and analyses made in connection therewith, and the plans for reconstruction, in order that complete and accurate information may be made available to the engineering profession.

Hence, if you had printed the complete report, your editorial demand for more light would have fallen rather flat because it would have been evident to the reader that the desire of the engineering profession for complete details of the investigations and studies had been anticipated and provided for. The Army Engineer Corps is now engaged in compiling and coordinating this data. It will be quite voluminous, but will be of great value to that part of the engineering profession which is charged with the design and construction of large earth dams.

The writer believes that the investigations and studies made in connection with the Fort Peck slide are the most complete and extensive of any investigations of a similar nature so far undertaken. The Chief of Engineers is just as anxious as are the members of the board of consultants that the engineering profession should have the full advantage of the investigations and studies which have been made. In addition to the primary documents mentioned in Section 9, which are now in course of compilation, there will be a paper, or papers, on the Fort Peck slide presented at the San Francisco meeting of Am. Soc. C. E. this summer. These papers are being written by the engineers best qualified to speak on the subject. The papers will then be revised in a more complete and more technical form and presented for publication in *Transactions* of Am. Soc. C. E. Together with the resulting discussions, it is believed that these papers will prove a real contribution to the existing knowledge of earth dams.

In considering a report, such as that on the Fort Peck slide, one should remember that the principal, for whom after all the report is prepared, wants to know two things: (a) the cause of the slide and (b) the measures of reconstruction that should be adopted to make the structure safe. It is believed that the board answered these questions in a brief, terse and unequivocal manner.

There have been other hydraulic fill dams which have had slides. In practically all such cases which the writer has studied, it was the shell which failed due to insufficient strength to resist the pressure of the core. In the case of Fort Peck, however, the evidence is overwhelming that the shell was not at fault, but that the failure was a shear failure in the foundation. Had Fort Peck been a rolled fill dam, the slide might have occurred just the same. As will be more specifically shown by a study of the papers and data mentioned above there is no sound reason why the accident at Fort Peck should lead engineers to abandon the hydraulic fill method of constructing earth dams.

JOEL D. JUSTIN
Chairman, Board of Consultants
Fort Peck Dam Investigation

[Nothing having any bearing on the cause of the slide in Fort Peck was omitted in our condensation of the board's report. Verbatim reproduction of the board's report would have required very few more lines of text than was required for our summary, but it would have been less easily understood because of its references to drawings which it was not feasible to reproduce.

We are in full agreement with the board's recommendations in Section 9 and we believe that their execution will not detract in the least from the force of our recommendation in the editorial "More Light Needed". The board of which Mr. Justin was chairman centered its study on determining the cause of failure and on passing upon decisions already made by the district engineer as to the best methods for reconstruction. Our editorial recommended that the study be carried beyond compilation and correlation of the board's data, that it be made the subject of a further study by experienced dam builders who would attempt to answer the questions that still are open.

EDITORS]

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JUNE 8, 1939

CHICAGO'S sanitary engineers quite properly have called upon the army Engineers to protect the water supplies drawn from Lake Michigan from added pollution due to a projected navigation improvement around Indiana Harbor and in the Calumet River. Under pressure of a Supreme Court order Chicago has spent and is spending millions of dollars to treat its sewage so that its diversion from Lake Michigan for river flushing purposes can be reduced. Local engineers hold that the proposed channel changes will require increased diversion from the lake through the Calumet Sag Channel, making it necessary for Chicago to reduce its diversion still farther to keep within the Supreme Court order, and at the same time will result in reversal of flow in the Calumet River during storms, thus sweeping polluted waters out into the lake. If there were a pressing need for the improved waterways there might be some justification for taking such a risk until sewage disposal plants in the Calumet Valley are completed; but there is not. The chief advocates of the waterway are the consistent enthusiasts for any and all waterways. Under these circumstances nothing should be done without full assurance that it will in no way add to pollution in Lake Michigan and jeopardize public health and safety.

Surety Bonding Again

SURETY BONDING is a perennial subject of debate and criticism. During a quarter of a century about every possible change has been rung in argument for and against its practices. Withal, corporate suretyship performs a necessary function in the construction industry; it is difficult to think of a substitute process of guaranteeing construction performance that is as widely applicable. Does surety bonding as a general practice give all the guarantee that those who pay its high cost have reason to expect? Does it play the vital part that it could play in stabilizing construction? A writer in this issue contends forcefully that it is not doing all that it can do in either respect; that fundamental reforms are needed in its practices. The argument is worth attention; for the present we leave it open without comment to the rival debaters in the surety and construction business.

Safety Nullified

A HEADING CREW in a Western tunnel was overcome recently when the incoming ventilating air was polluted at its source by fumes from a gas engine. The occurrence showed that construction hazards cannot be eliminated by mere installation of a safety device but that constant watchfulness is necessary. The device must work properly and be used correctly at all times, or its safety function is nullified. The tunnel case is typical of situations found on many a construction job. There are all too many safety switches wired closed, track derails spiked shut, eye-saving goggles danging around the necks of the workmen, and good ladders improperly placed. Eternal vigilance is the price of construction safety—vigilance by the men themselves and also by the supervisory forces to see that safety devices are properly installed and that negligence does not nullify their protection.

Heavier Motor Trucks

TRUCK BODY CAPACITY has increased to a point where the truck loading on the service bridges of a modern earthmoving job may exceed those of the construction railroad. As an example, the motor trucks in use on Shasta Dam, which governed the design of a bridge for either rail or motor-truck traffic, have body capacities of 25 cu. yd. And since such a unit with full load may weigh 50 tons or more, a bridge design problem of no ordinary magnitude is presented. Once again it is demonstrated that change in any single item of construction procedure leaves a train of other changes to be made in the interest of progress.

Prompt Action

THE CRUCIAL PROBLEM of express road development lies in financing right-of-way. Whether old routes are followed and right-of-way has to be widened, or new routes are adopted and new right-of-way must be provided, land purchases are involved which extend beyond all precedent. Particularly, city access and belt roads involve property purchases that few cities or states can find the

means to finance. Thus the most immediate task of express roadbuilding is being delayed, at the risk of penalties in higher costs and growing blighted areas. In its report to Congress (*ENR*, May 11, 1939) on a master plan for highway development, the Bureau of Public Roads found the only promising solution to be in the extension of federal credit to states for right-of-way purchases. It is cheering to note that as reported in this week's news pages, a step is being taken to implement the suggestion in actual legislation by Congress. The bill now being written by Senator Hayden of the Senate committee on roads, will, it is expected, be presented during the present session. Its authorship by one of the soundest thinkers in Congress on public roads development promises a document that will be constructive and safe.

Ever-Present Danger

PUBLIC-WORKS CONSTRUCTION is an always tempting field for those who would like to provide work relief regardless of consequences. The danger that federal construction might be thus exploited under the July 1 reorganization that will combine WPA with public works was pointed out only recently by the Associated General Contractors, who emphasized the seriousness of the new unemployment that would result. But a greater danger lies in hasty legislation by Congress. A recently introduced bill bears witness to this danger; it proposes to relieve unemployment by giving idle people jobs on public works. The consequences of any such legislation, however limited in scope and however safeguarded, are patent to anyone familiar with public-works problems. The probability is that at this late date such a new bill will not be enacted, but the chance should not be counted on with confidence, for Congress sometimes does the unexpected. Therefore, if construction workers realize the grave effects of such ill-considered legislation they will do well to make their views known to their representatives.

Tardy Protest

OBJECTIONS to the Chicago subway enterprise such as were presented by a group of merchants last week are sadly belated. They should have been presented months ago, at the time when the PWA board proposed its plan for relatively deep construction in place of the shallow construction originally proposed. Coming at this time, when work is actively in progress, they are not entitled to hearing, especially as the proper depth at which to build the subways is a matter for experts to decide, and experts did give it full consideration before the present plan was adopted. If the project is to meet the requirement of law as to time of completion, work must go ahead without interruption and no time is available for stopping to consider whether the whole plan should once more be changed. The issue raised by the protest of the merchants is therefore simply whether the project shall be shelved or shall go on. The plan now under execution will provide a serviceable and economical rapid transit system, with minimum disruption to the city's business and maximum value in laying the foundation for the ultimate city-wide transit system which Chicago needs. To interrupt its progress on the strength of unsubstantial and possibly insincere objections would be a grave mistake.

River Development

COMPREHENSIVE river development remotely similar to that of the TVA but fundamentally different in method is the purpose of the Brazos River enterprise, whose beginning is outlined in the present issue. The Brazos development contemplates the control and development of the entire river, with flood reduction as a primary motive but with water conservation and use most important in the end. In size the Brazos area is about equal to the Tennessee. But in place of the controversial federal authority setup for the Tennessee, the Brazos enterprise has a purely local control organization.

Federal aid through a WPA grant made the beginning of the Brazos development possible. Though the procedure in detail differs widely from that generally applied to WPA projects, employment is provided in due proportion to the cost of the work. This employment is no less real and valuable though its beneficiaries are not relief-roll men, and the Brazos plan may therefore show the way to extensive reform of WPA procedure.

Possum Kingdom Dam, first unit of the project, is independently interesting because of the unusual physical conditions reflected in its history and the divergent estimates of cost that mark it. The differences reported in the text of our article are in part due to varying opinion on the most suitable type of dam, in part to different judgment of foundation conditions. They constitute a reminder of the fact that dam-building is far from a stand-

ardized activity—of which fact other recent illustrations are furnished by Fort Peck with its catastrophic slide and Conchas with its surprising subsidence and rise. In each case the problem essentially goes back to the foundation, most uncertain and touchy element of dam construction.

An interesting coincidence is that the shale or clay of the Possum Kingdom foundation, in which the major differences of opinion centered, is closely akin to Fort Peck's notorious Bearpaw shale, though more thoroughly consolidated. Strong when protected from exposure but treacherous when allowed to dry and subsequently wet, these "shales" are more assured in respect to direct compressive strength than in respect to lateral stresses, whether shearing or frictional. Wide differences of opinion still exist with regard to both materials as foundation beds for dams, but in both instances the men who bear the actual responsibility for construction have concluded them to be safe and adequate.

In the field of dam superstructures Possum Kingdom is also of special interest. First flat-slab dam of long-span or massive-buttress type, the structure is distinguished by its freedom from buttress tensions, by the thorough-going use of contraction joints to forestall buttress cracking, and by careful attention to articulation. Its service record will add materially to current knowledge of dams.

Spotlight on Mapping

MAPS AND FEDERAL MAPPING had a brief period in the spotlight last week when the Department of the Interior, assisted by the National Broadcasting Company and the magazine *Life*, took the occasion of the reissue of the General Land Office master map of the United States as the occasion for emphasizing the importance of maps to the citizens of this country and for pointing out that a large area remains to be mapped. Without doubt, this dramatic way of drawing attention to a very essential but little known service will help to arouse public interest in maps. It is to be hoped that the reaction on Congress will result in the provision of more adequate funds with which to complete not only our land maps but also our topographic maps and control surveys.

Year after year public bodies and private corporations spend thousands of dollars to meet the deficiency in the public surveys, putting parties in the field to make topographic maps because none are available or because the existing ones are hopelessly out of date. Less than 25 per cent of the country is covered by accurate topographic maps. As recently as March of this year the Secretaries of War, Commerce and Interior recommended to the Senate the immediate inauguration of a mapping program calling for $5,000,000 the first year, $6,000,000 for the second and $7,000,000 for the third and succeeding years until the present deficiency is made up. But Congress has not acted on the recommendation.

The amounts required are not large, yet it is difficult to get Congress to make provision for this essential service. Only by occasionally turning the spotlight on our mapping services can we hope to gain adequate funds with which to produce all the maps we should have and keep them up to date.

Modern Water Control

AMONG THE MANY ADVANCES in waterworks practice, one of the outstanding is the development and perfection of automatic control systems. Particularly is this true in connection with pumping operations. Relatively few plants, however, have availed themselves of the controls now available, which range from a simple pressure shut-off system to a complete control mechanism that performs all the functions of a highly skilled and ever watchful operator.

What can be achieved in automatic operation combined with supervisory indication is exemplified by the work of the Baltimore Bureau of Water Supply described on page 93 of this issue. Of the nine pumping plants in Baltimore, there are only two in which the operators have need to exercise judgment in the manipulation of station facilities. All the others operate independently of human guidance—they stop and start as required by pressure and volume demands, and they are protected against every possible mechanical or other failure by means of ingenious electrical and hydraulically controlled devices. But the crowning achievement is the supervisory indicator system, by means of which a complete "report" on operating conditions can be obtained at any time from any place, merely by calling the station telephone.

The Baltimore installation represents the ultimate in automatic control, in which has been incorporated a quarter century of experience, and can well serve as a guide for sound practice elsewhere. However, its value lies not only in demonstrating what can be accomplished with complete automaticity of operation but perhaps even more in suggesting the many opportunities for improving and simplifying water service by utilizing mechanical means of central supervision and control.

Possum Kingdom Initiates Brazos Development

Contents in Brief—Flat slab dam of long spans, and first of massive buttress type, is being built as first step in conserving waters of Texas' largest river. Uses WPA funds but normal contract procedure. Founded on shale. Sliding factor of 0.42 used. Special details to insure cooperative action of deck and buttresses. Special excavation methods to shield shale from air before concrete is placed.

SOME TWENTY-FIVE MILES northwest of the resort town of Mineral Wells on the plains of central Texas, a dam of unusual background and novel design is under construction. The neighborhood of the site is known as Possum Kingdom, as a reminder of an earlier population. Here a reservoir of nearly a million acre-feet is being created, as the initial element of a flood-control, water-conservation and power-development system that ultimately may include 13 dams along the course of the Brazos and its tributaries to serve the needs of the entire drainage area.

An outstanding feature of note in this project is that it represents part of a comprehensive stream-basin development reminiscent of the TVA but lacking its agricultural and social uplift objectives. Another is the fact that the dam is being built with WPA money but under a normal construction contract and by normally hired labor, although available relief workers are also employed. A third feature lies in the fact that wide differences in design and estimate of costs delayed the start of construction for two years, and that the dam now being built will cost about two-thirds as much as its costlier rival.

In addition, the dam is noteworthy structurally, being the first of the so-called massive-buttress type of flat-deck buttress dam. It is 189½ ft. high above lowest foundation and 2740 ft. long (including terminal dike), planned to raise the water 130 ft. from original river level to normal pool. The middle part of the length of the dam forms an overfall spillway flanked on either end by bulkhead sections; the power house occupies four bays adjacent to the north side of the spillway. Other technical data and dimensions are given in the accompanying tabulation.

Unusual construction features of the dam include diagonal contraction joints that divide the buttresses into independent columns, keyed together for shear transmission; cushioned seating of the deck slabs on the buttresses; keys to hold the slabs into the buttress tongues in order that the deck load may contribute fully to the stability of the structure; and clay foundation. This clay (called Wolf Mountain Shale by the geologists) occurs in the river section and at the north bank generally at about El. 850, or 20 ft. below river level. The designers endeavored to place all footings on the blue shale so far as practicable, but on the south hillside many footings are on sandstone overlying the shale.

An incidental feature of interest in this undertaking is the fact that the Federal Power Commission has taken jurisdiction over design and construction as well as over power sales. It has imposed certain requirements as to working stresses, cement content of the concrete and struc-

Fig. 1. Possum Kingdom Dam, first of massive buttress type, which will store nearly a million acre-feet of Brazos River flood waters. View looking upstream shows power house in center and part of spillway immediately to the left. Space for three 12,500-kw units (two to be installed at once) is provided in the power house. Turbines are designed to operate on a 130- to 63-ft. range of head.

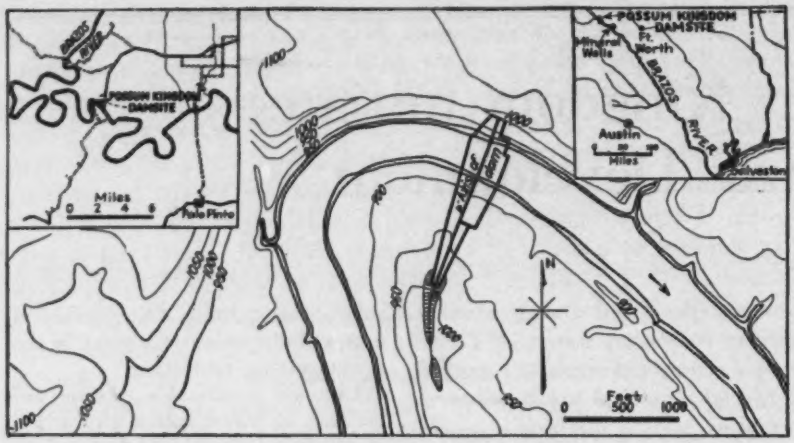


Fig. 2. Intrenched several hundred feet deep in the flat-lying rock strata of the central Texas plain, the upper Brazos River, despite its meandering course, provides a reservoir site of large storage capacity at Possum Kingdom.

tural details—probably its first excursion into technical control of dam construction.

Evolution of Brazos plan

Flood-control study dates back several decades; detailed planning began 12 years ago. In 1929 the Brazos River Construction & Reclamation District was formed, under state authorizing legislation initiated by John A. Norris, then head of the State Board of Water Engineers, who became general manager and chief engineer of the district in 1935. Later the district employed the Ambursen Engineering Corp. of New York to make studies and plans for comprehensive control and development of the river.

Under the enabling act, certain state taxes paid by the ten counties of the 65 comprising the district which had suffered most flood damage were placed to the credit of the district for a period of 20 years, but the district could not levy taxes or borrow money on the credit of the lands or communities in its area. The receipts from this tax diversion, about $300,000 a year, with the expected revenue from power produced at some of the dams, would go far to carry the enterprise, but the use of federal funds was essential to getting the program under way at once. Accordingly, an application for a WPA allocation to build all 13 dams of the series was made in 1935, based on preliminary cost estimates. The President approved the project in the amount of about $30,000,000. Subsequently the WPA allocated about $3,100,000 for the Possum Kingdom Dam, specifying that it should be designed and built under direction of the Engineer Corps of the Army.

Accordingly, site investigations and design studies were begun by the U. S. Engineer Corps under Capt. H. A. Montgomery, appointed district engineer with headquarters at Mineral Wells. An informal consulting board called to advise on foundation and design problems included W. P. Creager, William Gerig, J. P. Growdon, W. H. McAlpine, J. D. Justin, C. M. Wellons, Prof. W. J. Mead, and G. A. Hathaway. The ground was explored by borings and test pits, the hydrology of the reservoir was studied, and various dam types were considered. Two forms of dam were estimated—concrete gravity with inclined upstream face, and roundhead buttress. The cost was estimated at nearly $8,000,000, not including powerhouse.

Because of the large excess of this estimate over the allocated funds the Bureau of Reclamation was asked to review the estimate. Following its approval of the Army estimate the WPA concluded not to provide the additional money and the Army Engineers withdrew from the undertaking. Subsequently an allocation of $4,500,000 was made direct to the district for construction under its own engineers.

District adopts slab type

Organization of the district for the present work was accomplished by engaging the Ambursen Engineering Corp. as designing and supervising engineers, represented by Charles P. Williams, former reclamation engineer, as project engineer. Re-study of a wide range of dam types, including gravity, multiple arch, flat-slab, roundhead buttress, rockfill and

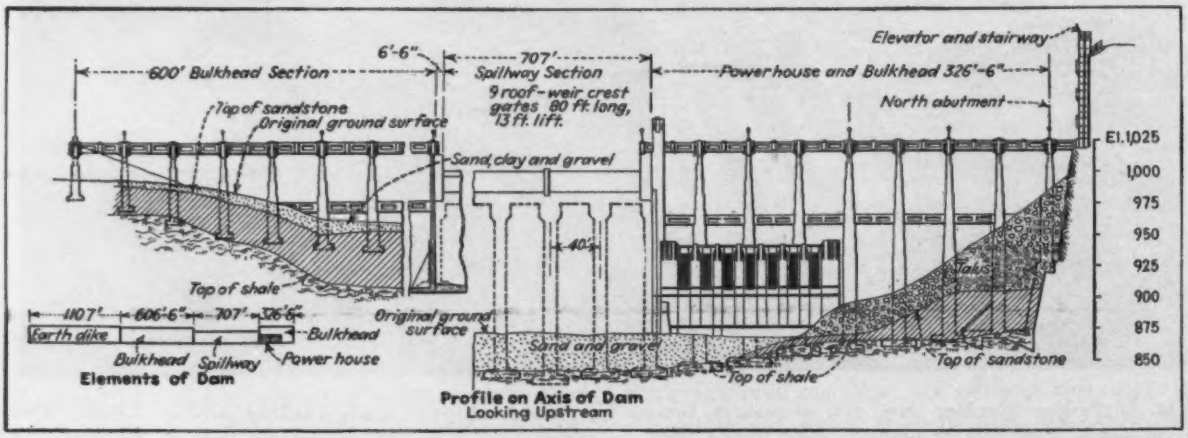


Fig. 3. Possum Kingdom Dam abuts against a vertical rock wall on the north and a sloping hillside on the south, with footings in the river section on a hard blue shale.

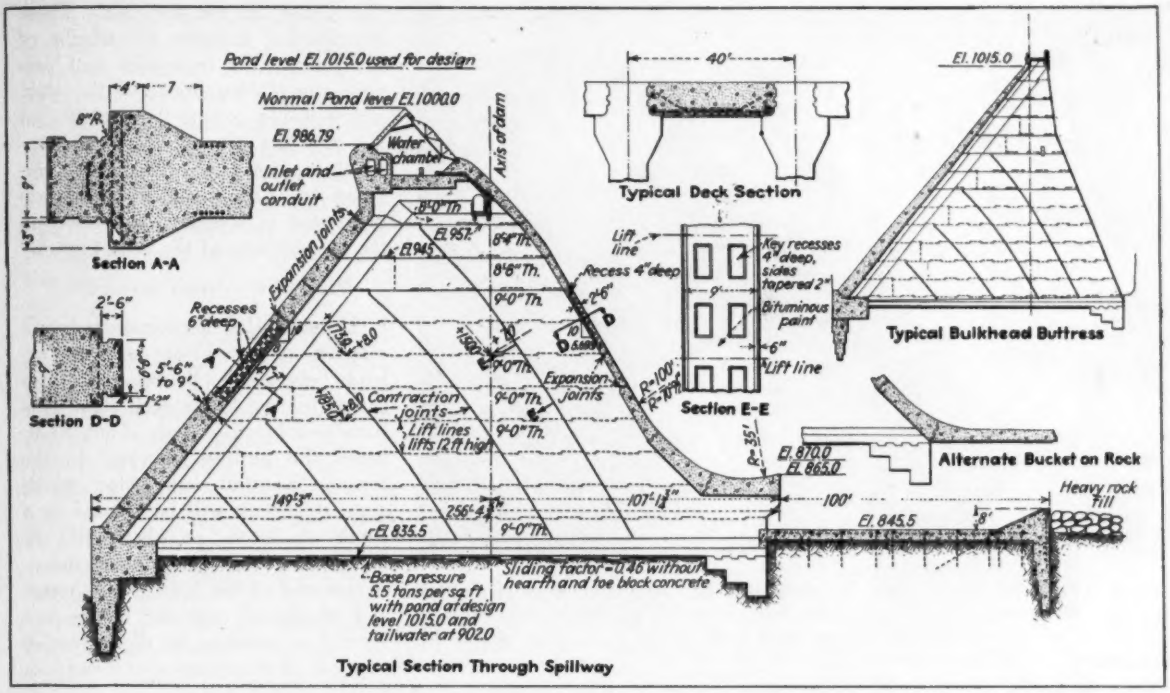


Fig. 4. Details of Possum Kingdom Dam. Buttresses, 9 to 10 ft. thick, are cut by diagonal contraction joints to provide virtually independent columns to carry the deck load to continuous reinforced concrete footings.

earth, led to adoption of a massive-buttress flat-deck dam of 40-ft. spans as most economical and best suited to a spillway-crest-gate layout of high capacity and to the power house installation.

Foundation conditions

The rock strata in the vicinity of the dam comprise (from top down) several thick beds of hard limestone, layers of gray sandstone, hard sandstone, oxidized sandstone, and sandy shale, grading into the hard blue clay of the Wolf Mountain formation. The limestone contains many solution channels and is separated from the top of the gray sandstone by a weathered contact zone, which made thorough provision for grouting necessary.

Field and laboratory studies of the blue shale, the foundation stratum for the dam, were carried out in the course of the Army studies. According to Prof. Mead the material is a "practically pure clay shale compacted by pressure only, without intergranular cementation. It has adequate compressive strength for very large loads, but is subject to large elastic deformations when unconfined. Where exposed it shrinks and cracks on drying, and alternate wetting and drying causes it to slake to a plastic clay." Prof. Mead states that the material contains 6½ per cent moisture by weight, is tight and impervious, and requires no grouting.

Shear tests of the shale indicated an ultimate value of 100 to 125 lb. per sq.in. plus 0.4 the normal pressure. The angle of internal friction was determined as 41 to 52 deg. Friction tests of blocks of concrete 5 ft. square cast on the shale showed values of 0.8 to 0.9 moving friction, with higher values at initial failure. That the material has adequate bearing power is made apparent by the fact that it carries some 200 ft. of overlying rock in the river bluff.

With respect to design, the sliding coefficient to be used was considered critically important. Preliminary designs were made for a sliding factor of 0.75, but the final design is stated to have a sliding factor of 0.45 for the bulkhead section and 0.42 for the spillway section.

Design features

The thick buttresses have no reinforcement except along the deck haunches and in the tops of the bulkhead buttresses. Diagonal contraction joints were therefore used on the lines of principal compressive stress, as they were in the highest of the buttresses of the Rodriguez Dam. They required keying to transmit any shear that might tend to develop between individual columns or buttress sections. The contact faces of the contraction joints are painted with a bituminous coating to assure a parting of the concrete. Pockets 2x3 ft. by 4 in. deep are formed in the abutting face of the first block cast, to key with the adjacent block.

The tops of the 12-ft. lifts of the buttresses are stepped 6 in. deep in 8-ft. lengths to form keys, and the top surface of each lift is prepared by blasting with water and air and by depositing a layer of grout ahead of the concrete of the next lift, to secure monolithic bond as far as possible.

A different keying arrangement was worked out at the junction of deck slab and buttress. The seat of the slab on the supporting haunch or shoulder of the buttress is slightly beveled to prevent binding. In order to prevent excessive tension in the buttress haunch due to sliding friction when the deck slabs contract under temperature changes and to assure a seal, this seat is tar coated. The haunch surface is first coated with a bitumastic primer, covered with a flexible bitumastic enamel to seal any hair cracks; then a troweled

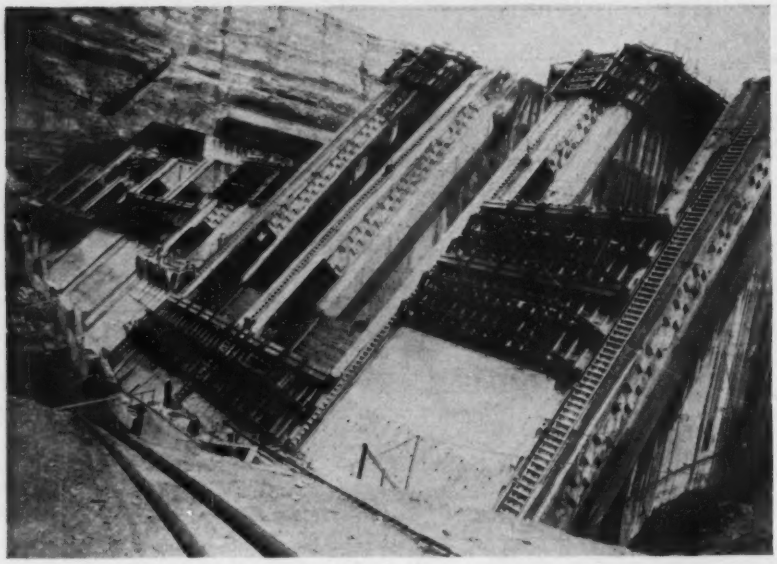


Fig. 5. Upper and lower forms for concreting the lifts of the deck of Possum Kingdom are suspended from steel truss bridges resting on the buttress tongues. The sloping cut seen in the face of the north bluff, at left, is a notch to seat the deck slab.

layer of "Mastictar" is applied. As tests proved that friction is reduced by the inclusion of a layer of metallic or mineral fabric, a $\frac{1}{16}$-in. asbestos cloth is rolled into the Mastictar, and then coated with a final troweled layer of Mastictar. This final coating is also applied to the faces of the buttress tongue and its keys, adjacent to the ends of the deck slab, to prevent possible water seepage at that point and to provide expansion space for the deck slab. These key notches transmit the weight of the slab to the buttresses and prevent any sliding down of the slab, which would reduce the stability of the structure. At the same time upward expansion of the slab is provided by $\frac{3}{4}$-in. pads of asphalt-impregnated expansion joint filler on the top surfaces of the deck keys.

Provision against underflow

At the foot of the upstream deck a massive concrete block or girder extends between the buttresses to form a seat for the lower deck slab. This transition block extends about 35 ft. below the buttress footings in the form of a cutoff wall, below which a grout curtain will be formed to a depth of 50 ft., or about 100 ft. below river level. At the toe or downstream end of the buttresses, shorter and shallower concrete blocks are formed to increase the sliding resistance. A downstream cutoff wall is ance.

Construction of dam

After scaling and trimming the north cliff to remove loose and overhanging parts that might endanger work below, the north abutment and

TECHNICAL DATA ON POSSUM KINGDOM DAM

Hydrology—Drainage area above damsite is 13,050 sq.mi., with a possible 7,000 sq.mi additional high plains area that may contribute some flow at times. Mean flow at dam, 1,450 cfs, or about 1,000,000 acre-ft. a year; mean of high-water month, 3,680 sec.-ft.

Peak flow, 164,000 cfs estimated from observations; 325,000 to 600,000 cfs assumed possible by various authorities, or 25 to 46 cfs per sq. mi. River slope at site about 1.75 ft. per mile.

Pool level is limited by the town of Graham, 25 miles upstream, to El. 1000, giving about 130-ft. raise from oirginal river level (El. 870). Storage at El. 1000, 757,000 acre-ft.; at 10-ft. surcharge, 990,000 acre-ft. Drawdown capacity from El. 1000 to 937, 660,000 acre-ft. Silting is not expected to be a serious hazard; the reservoir life is estimated at about 250 years.

Dam Structure—Height from lowest buttress footing (El. 834.5) to top of gates (El. 1000) is 165.5 ft.; to top of bulkhead and dike crest, 189.5 ft.

Length over all, 2,740 ft.; earth dike, 1,107 ft., south bulkhead, 600 ft.; spillway, 707 ft.; powerhouse and north bulkhead, 326 ft.

Buttresses spaced 40 ft. c. to c.; thickness, 9 ft. in spillway, 10 ft. in bulkhead sections, reduced in several steps near top. Deck slope, 10 on 8 upstream, 10 on 5.7 downstream. Deck thickness varies from 9 ft. at lowest point to 5 ft. at top.

Buttress footings are spread to give 5½ tons per sq.ft. foundation load, some being rectangular and some trapezoidal in shape to secure uniformly distributed pressure. Sliding factor for spillway section 0.46, ignoring hearth and downstream footing toe-block; 0.42 with allowance for weight of hearth and toe-block. For bulkhead section 0.56, ignoring weight and horizontal thrust value of toe-block concrete; 0.45 with allowance for weight and with horizontal thrust value of toe-block concrete at 5½ tons per sq.ft.

Buttress compression at maximum is 253.9 lb. per sq.in., and is practically uniform on horizontal planes. Deck stress is 800 lb. per sq.in. in concrete, 18,000 lb. per sq.in. in steel.

Concrete—Moderate-heat cement is being used throughout. Three classes of concrete are specified, for crushing strengths of 3,000, 2,500 and 2,000 lb. These strengths are usually obtained at from 28 to 60 days. Cement factor about 1 bbl per cu.yd. in buttresses and footings, 1¼ bbl in deck (Fed. Power Com. requirement). Lowest grade of concrete is used for filling only; middle grade for buttresses and hearth; highest grade for decks.

Principal Quantities—Earth excavation, 350,000 cu.yd.; rock excavation, 150,000 cu.yd.; embankment, 40,000 cu.yd.; class "A" concrete, 80,000 cu.yd.; class "B" concrete, 240,000 cu.yd.; class "C" concrete, 5,000 cu.yd.; reinforcing steel, 7,000 tons.

Contracts for construction of dam, including materials, $3,850,000; foundation contingencies and others, $750,000; total, $4,600,000.

Contracts for power house structure, including materials, $550,000; hydraulic and electrical power house equipment, 2 units, $650,000; total, $1,200,000.

Total cost of project complete including power house and equipment, $5,800,000.

Organization—Owner, Brazos River Construction & Reclamation District; John A. Norris, Temple, Tex., general manager and chief engineer. Studies, design and direction of construction by Ambursen Engineering Corp. of New York. Resident staff, Charles P. Williams, project engineer; L. H. Huntley, construction engineer; H. F. Stubbs, office engineer; Edmund D. Knight, field engineer; C. C. Tinkler, chief inspector.

Contractor, Lytle-Johnson Construction Co. (C. F. Lytle Co., Sioux City, and Al Johnson Construction Co., Minneapolis. Superintendent, O. S. McCormick; field engineer, William H. De Butts.

Previous *ENR* References to Possum Kingdom—Dec. 24, 1936, p. 910, "Work on Brazos River Dams Limited by an Injunction"; Dec. 16, 1937, p. 964, "Increased Amount Allotted for Possum Kingdom"; Jan. 20, 1938, p. 92, "Bids Opened in February on Possum Kingdom"; May 26, 1938, p. 729, "Design Restrictions on Possum Kingdom."

north part of the river channel were inclosed in a cofferdam consisting on the river side of a double line of sheetpiling with earthfilling and on other sides of earth dikes with steel sheetpile cover. Excavation for footings proceeded within this cofferdam and on the south slope simultaneously. Determination of final level of the buttress footings depended on the kind of ground revealed by the excavation.

Rock excavation is kept at least 6 in. from the final face, and trimming to the actual foundation bed is done only immediately before concrete is placed, to guard against drying out and air slaking of the shale. The sides of excavations in some cases are cut with a power shale saw, and these faces are at once sprayed with a bituminous coating to retain the moisture in the shale.

Buttress footings are cast separate from the buttresses, key notches being formed in the top of the footing slabs as a shear seat for the buttress concrete. The buttresses are concreted in 12-ft. lifts, alternate sections between contraction joints being concreted first and the intervening sections later.

Concreting the transition block is a separate operation, following on and so far as possible continuous with the concreting of the cutoff wall. Two-inch pipes set into the upstream cutoff wall make provision for the drilling of grout holes. At the time of writing, only a small amount of grouting has been done. Holes that penetrate only blue shale generally take only a fraction of a bag of cement per hole. A few holes took substantial amounts of grout, one as much as 1300 bags. Deck concreting was also carried on as a separate job and in many cases was not begun until the buttresses had been built practically to the top.

Construction cableway

Concrete and forms are handled by two 1900-ft. cableways. Concrete buckets are of 2-yd. and 4-yd. size. Hearth and toe-block concrete is largely handled by trucks carrying buckets from the cableway.

All sand and small sizes of gravel are dredged from the river just above the damsite. Additional large aggregate is obtained as crushed limestone from a quarry opened near the south abutment. Limestone crusher dust is occasionally added to the sand.

Baskets of Cobbles Hold Slopes

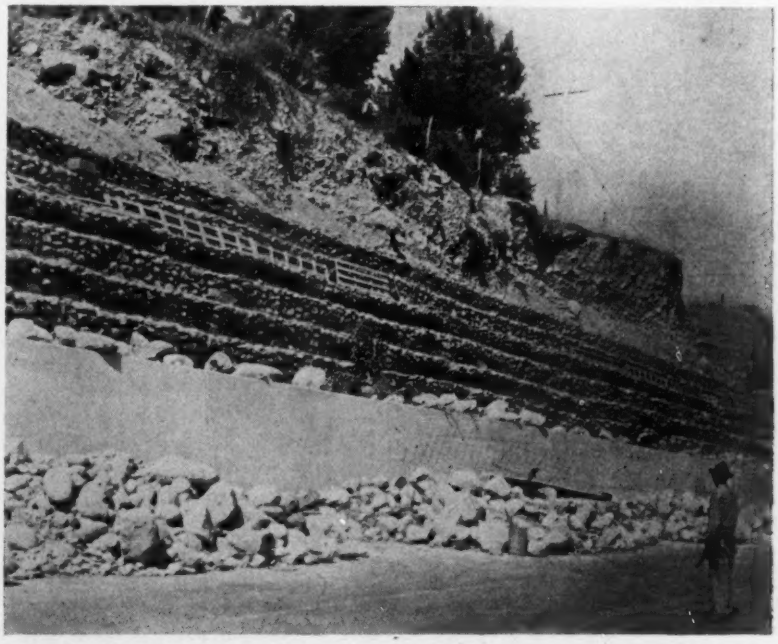
STEPPED COURSES of wire containers filled with cobblestones and laid up like masonry have been successfully used for holding the slopes of cuts through rolling gravel and boulders by the Nevada state highway department. The particular road cut illustrated has a 50-ft. bank and is on U. S. route 40 west of Reno, Nev.

The first step in construction was to make the necessary excavation and pour the concrete toe wall, 500 ft. long, of gravity cross-section. Behind this, and level with the top of the wall, a backfill was made, using the loose material on the slope. Upon this leveled surface was erected the first, or lowest, tier of wire basket retaining walls. The baskets, preformed by the contractor at his equipment yard, consisted of 6-gage 6x6-in. mesh wire which was set up in place on the slope in a light wooden frame-work to retain the rectangular shape while the basket was being filled.

Hand-picked cobbles were placed in each basket beginning with larger sizes and filling in the interstices with smaller stones. Each basket section was made 7 ft. long and when filled to the prescribed height the flap top was folded over, lapped 1½ ft. and tied together with No. 9 wire. Adjoining baskets were fastened end to end to make a continuous course for the full length of the terrace. On each terrace two courses of baskets were built up; one 3x3½ ft. in section on the bottom and on this a smaller section 2 ft. square. This construction was continued upward in successive terraces on an average slope of 1 on 1½ until this slope cut the original ground surface.

In the work illustrated the longest basket tier is 320 ft.; the shortest, near the top, is 100 ft. Altogether there is a total of 1,670 lin.ft. of double-tier baskets containing 897 cu.yd. of stone. The cost of the wire mesh in the baskets and the labor for filling them was $7 per cu.yd. This cost does not include excavation or backfill.

The slope protection work was part of a highway improvement involving about 4 mi. of roadway carried out by the Isbell Construction Co., Reno, Nev. R. A. Allen is state highway engineer.



A Nevada cut slope retained by terraces of cobblestone held in wire containers.

Floating Turntable Carries Fair Exhibit

Contents in Brief—The main feature of the Ford Motor Co. exhibit at the New York World's Fair is a truncated cone turntable 100 ft. in diameter and 30 ft. high, supported by a continuous pontoon in a circular moat. The structure consists of 32 radial steel trusses covered with a stepped wooden mantle, their lower ends framed into a steel pontoon. A 2-hp electric motor turns the exhibit at slow speed.

AT THE FORD Motor Company's exhibit at the New York World's Fair the principal feature is a truncated cone, 100 ft. in bottom diameter, 30 ft. high at the center, that revolves slowly to display models of car manufacturing processes built upon the stepped surface of the cone. The exhibit designer and Ford officials conceived the idea of a turntable display, but the Ford engineers, the architect and the designer had to figure out how to build it and make it turn. Naturally, the first thought was to build a conventional railroad type turntable operating on a curved track. However, as the exhibit buildings rest on a few feet of ashes and meadow mat over 90 ft. of muck, suitable foundations for such a turntable would have been expensive. Furthermore, the designer demanded smooth, level, even and absolutely quiet rotation—requirements hard to meet with the rail type turntable.

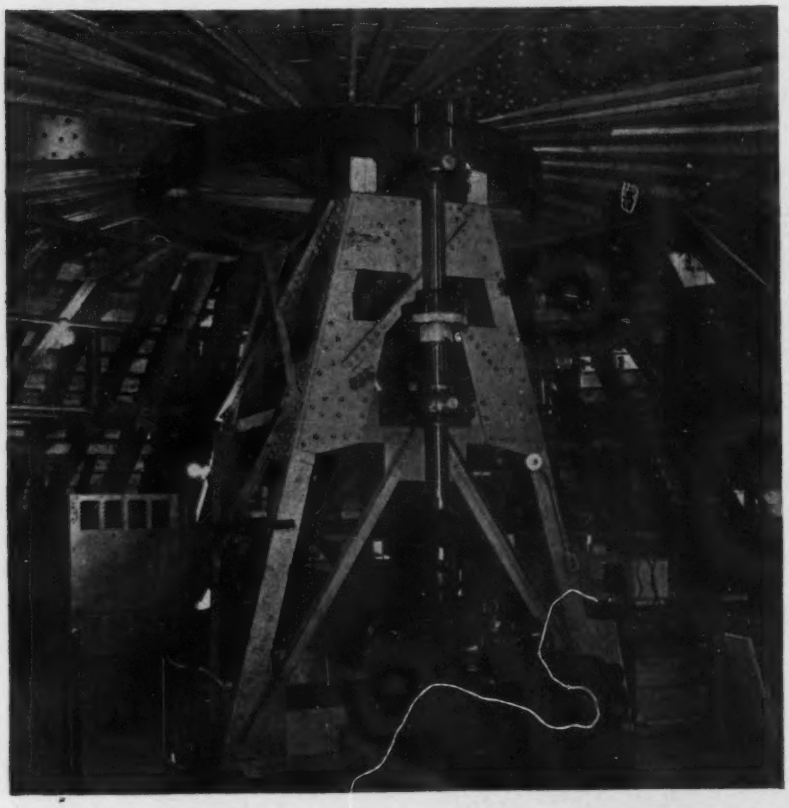


Fig. 1. Driving mechanism for turning the exhibit, located under the turntable. The tower carries only the drive assembly; it supports no part of the revolving structure. One of the shear pins that transmits the rotation power between ring gear and turntable can be seen to right of the pinion at top of drive shaft.

A revolving structure floating in water proved ideal for this situation. The design involves a series of radiating inclined steel trusses, framed at the top into a circular steel cage. At their lower ends the trusses rest on and are framed into a continuous circular steel pontoon. This pontoon is 10 ft. wide and 3 ft. 4½ in. high, built of $\frac{5}{16}$-in. steel plate reinforced with 10-in. bottom ribs, top and bottom ring angles, vertical stiffeners and knee braces. As its center is on on a 35-ft. radius, the steel trusses extend 10 ft. beyond the outside shell of the pontoon. Trusses and circular cage form a sort of dome, unsupported at the center.

The concrete floor under the turntable is depressed 1 ft. 4 in. below the general building floor level. Into the depressed floor is sunk a concrete-lined moat filled with water. Fully loaded, the display weighs 152 tons, and the pontoon clears the sides of the moat by 10 in. and the bottom by 8 in. The bottom slab is 8 in. thick, the sidewalls are 6 in. Both bottom and sides are covered with membrane waterproofing, and the bottom membrane is protected by 1½ in. of cement plaster. Circular timber curbs at the top of the curved walls at floor level hold the wall membrane waterproofing in place. The moat carries 20,000 gal. of water, regulated and controlled by a float valve.

The face of the cone is sheeted with 25 curved wooden steps, fastened to the steel trusses through a nailing strip bolted to the upper side of each top chord; the circular top cage is covered on side and top with wood sheeting. The animated models of manufacturing processes are spread around the steps.

Drive mechanism

The tops of the trusses frame into a circular steel cage 22 ft. in diameter and 10 ft. high. Top ribs of the cage are 10-in. radial beams, carrying plates top and bottom at the center; the remainder of the cage

framing is of angles, except for a bottom center plate and three sector plates framed between bottom ribs to carry the drive pin sockets. The driving mechanism is mounted on a steel tower, resting on the depressed floor, that reaches almost to the bottom of the cage. Access to the tower and mechanism is through a concrete tunnel under the moat, terminating in a stairway under the turntable.

Extending upward from top of tower through the bottom cage plate is a 6-in. shaft or king pin that carries no load and transmits no torque, merely acting as a centering pin. Running free on his shaft is a 108-in. horizontal ring gear, from which, at three points around its rim, steel pins extend upward into rubber-lined sockets in the bottom cage plates. These pins transmit the drive power from ring gear to the turntable structure. The pins are not fastened to the socket, so do not bind if the turntable should tip slightly under an eccentric load.

Fig. 2. Part of the continuous steel pontoon upon which the entire exhibit floats. Under the bottom the water is 8 in. deep, at the sides it is 31 in.

Power for rotation is supplied by a 2-hp. electric motor on the floor alongside the center tower, operating a vertical shaft through a gear speed reducer set at a ratio of 515:1. Meshing with the large ring gear at top of shaft is an 8½-in. pinion. A typical cross-section of the structure, including the driving mechanism, is shown in Fig. 2.

Control

The drive motor operates on 220-volt direct current, converted from a 208-volt alternating current supply by a motor generator. A direct-current motor was preferred because it allows more flexible operation. Normal speed of rotation of the turntable is 9 rev. per hr.; top speed is 12 rev. per hr. The motor control system permits full rheostat control of the rotating speed. Ratio of motor speed to turntable rotation is 6,650:1. A ring collector (Fig. 4) at the top of the king pin transmits electric current from the stationary tower to the revolving structure for the lights and 112 small motors (1/20 hp or less) required to operate 87 individual displays carried by the turntable.

Direction

The general exhibit was designed by Walter Dorwin Teague; Albert Kahn, Inc., Detroit, was the architect and Hegeman-Harris Co., New York, was general contractor. The American Bridge Co. submitted the original design for the turntable, and built the structure under slightly modified plans. Monitor Controller Co., Baltimore, designed and built the electric control system.

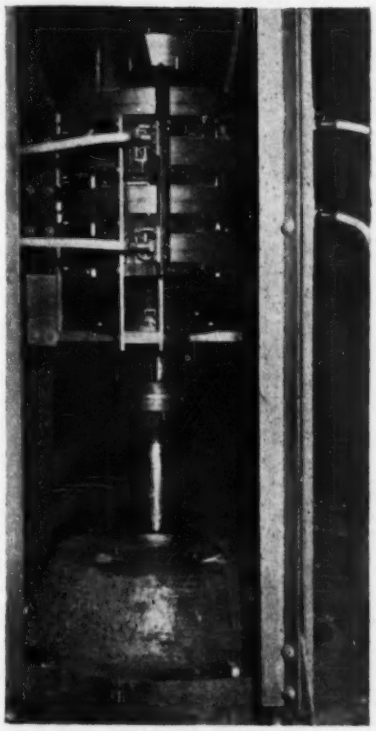


Fig. 4. Ring collector at top of king pin transmits current from stationary to rotating parts of the exhibit.

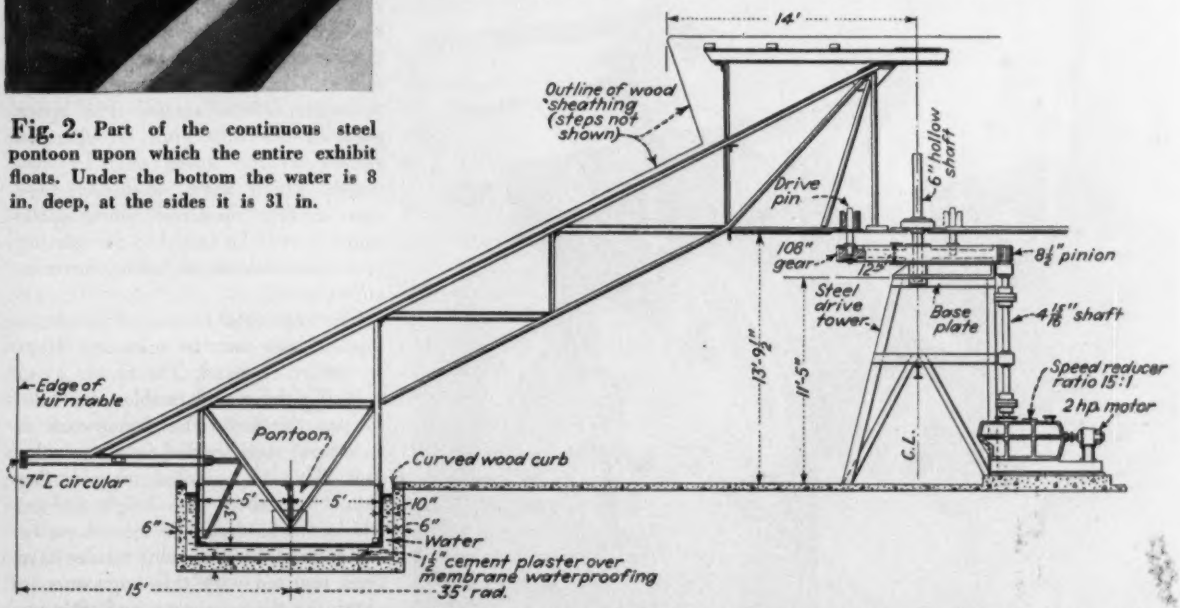


Fig. 3. Relation of the structural framework, steel pontoon and driving mechanism is shown by this typical cross-section of the turntable. Steps on the sloping face, which carry the individual displays are not shown.

Proving Rings Register Soil Shear

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Steel proving rings adopted for measuring shear resistance in an improved shear-testing machine at M.I.T. soils laboratory

PROVING RINGS substituted for bellows on the well known shear-test machine (*ENR* May 21, 1936) devised by Glennon Gilboy for the M.I.T. soils laboratory have, with a new shear box, greatly improved its accuracy and ease of operation. The new machine with the proving ring and improved shear box in position for making a test are shown by the accompanying illustration.

A standard proving ring was considered, but it was too elaborate and costly. Prof. A. V. de Forest of M.I.T. suggested using a ball bearing race and measuring the deflection (which is a function of the applied load) by a dial gage. Two discarded outer ball-bearing races were reduced to different thicknesses so that one could be used for light loading and the other for heavy loading.

Two approximate formulas are needed to calculate the size of ring required to fit the given purpose of deflection and load carrying capacity:

$$D = .149\ \frac{Pr^3}{EI} \text{ and}$$

$$f_{max} = .318\ \frac{Pry}{I}$$

where D is the deflection of the ring along the diameter along which the concentrated load P is applied, r is the radius to the neutral axis of the cross section of the ring which has a moment of inertia of I, a modulus of elasticity of E, a distance of y from the neutral axis to the extreme fiber which has a maximum stress of f_{max}. Any consistent unit may be used in the above formulas.

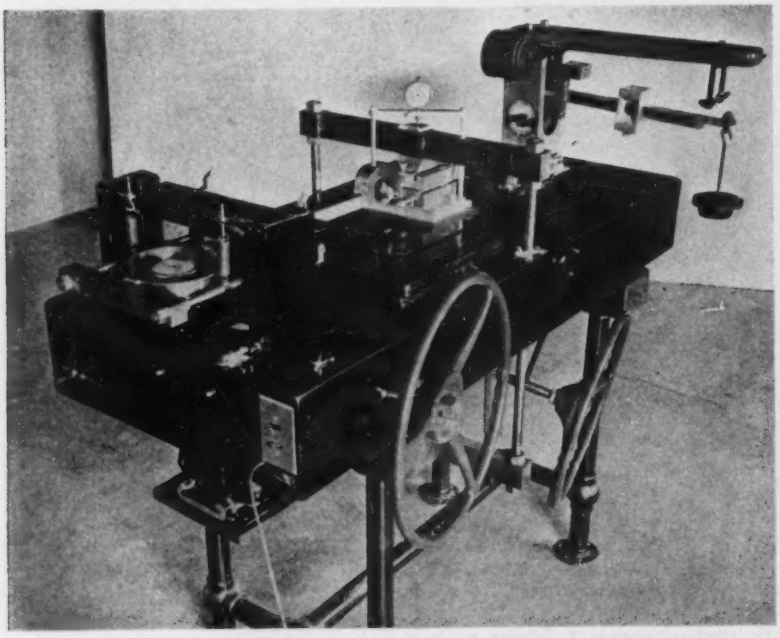
The dial gage can be made to indicate the load directly by having the ring ground to a size where one division represents a convenient unit of load. The light-weight loading ring in the M.I.T. laboratory was designed to have a capacity of 200 lb. with ½ lb. representing 1/10,000 in. on the Ames dial gage; one division represents 5 lb. on the heavy loading ring which has a capacity of 1,000 lb. To minimize permanent set and for strength the rings should be of high carbon steel, heat-treated.

Before calibrating the ring, it should be given its maximum load and then reduced to zero a dozen times to get rid of hysteresis effects. The ring is calibrated by placing it on the platform scale and the loads are applied by the vertical loading arrangement of the shearing machine. When the ring has not been used for several days, it should be put through the loading and unloading cycle three times, using about 50 per cent of the capacity load before a test is made. This may be done while it is in place on the machine by pulling against the shear box with the locking pins in place. The dials can be read to a fifth of a division which corresponds to reading the light ring to 1/10 lb. over a range of 200 lb. and reading the heavy ring to 1 lb. over a range of 1,000 lb.

The shear box is made of aluminum with duraluminum posts and screws which saves weight, making it easy to handle. The lower porous stone or grate is in a holder similar to the upper one and several fillers are provided that may be placed beneath the lower grate so that different thicknesses of the sample may be used and still have the shearing plane in the center of the sample. The upper part of the box may be clamped rigidly to the lower part by two screws which when unscrewed also serve as the stop screws allowing the upper part to be raised in the spacing operation without permitting horizontal motion.

The horizontal motion of the shearing machine may be operated either by motor or hand. The motor gives a steady drive and enables one man to run the test. The framework is structural steel welded into one solid unit. This is mounted on pipe leg supports at about table height and the whole machine can be moved easily.

Remarkably consistent results have been realized with this apparatus in obtaining the maximum and ultimate shearing resistance of the soils tested.



Shear test machine using steel proving rings for measuring the pull.

Reforms Needed in Surety Bonding

Contents in Brief *— An old hand in surety selling, writing anonymously, tells of reforms in bonding that promise new markets and better service to construction.*

GENERAL CONTRACTORS of responsibility have long desired to improve competitive conditions in the construction industry to eliminate the undesirable or irresponsible elements in the business from competition for what is left of private construction.

Sub-contractors and materialmen, who suffer most from incompetent or irresponsible general contractors, are sympathetic to these aims and are particularly anxious to avoid the heavy financial burden which the necessity of transacting their business on a credit basis actually imposes.

Owners and their representatives, the architects and engineers, are likewise interested in plans which will improve the quality of their construction while reducing the cost.

With the improvement of general economic conditions there is certain to be released a substantial backlog of privately owned and financed industrial and commercial construction and many surety underwriters feel that realization of the desires of the three groups above referred to will prove to be a powerful stimulus to the early development of this highly desirable activity. These far-sighted underwriters, admittedly in the minority, feel that corporate suretyship can accomplish these reforms—but only if the surety business is itself reformed.

Much of the popular criticism of corporate suretyship is due to the fact that it is underwritten by insurance companies whose psychology gives only lip service to the distinction between pure insurance and the extension of credit which is suretyship. If the business of corporate suretyship as applied to the performance of construction contracts is to survive at all, to say nothing of reaching the ultimate aim of leadership of the construction industry to new and fairer fields, the executives of the surety companies must heed the advice they have been receiving from their field representatives throughout the country and give immediate and favorable consideration to suggestions for drastic reforms of rates, coverage and underwriting and loss-adjustment practices.

The changes most frequently recommended to surety executives may briefly be summarized as follows:

Lower premium rates

Existing premium rates should be drastically cut on all classes of contract bonds. The revised premiums should be on an annual basis or for the term of the contract in every case. In promulgating special rates for bonds on contracts in excess of $2,500,000, the surety companies have recognized the principle that there is some relation between the size of a contract and the stipulated time for performance. And if the sureties will also acknowledge that, by the introduction and improvement of mechanical aids in the performance of every type of construction contract, the performance of work has been so speeded up that practically no contract is uncompleted at the expiration of one year excepting contracts which are large enough to be specially rated, then the sureties will realize the inconsistency of their present rating system which taxes smaller contracts, completed at an earlier date, at a higher rate and total premium than is frequently applied in the case of a much larger and longer-term contract.

Labor (employed by the general contractor, the subcontractor and by materialmen and manufacturers alike) is still the most speculative element of cost, as measured by production as well as by wage scale, and the period of time consumed in the performance of a contract is admittedly of greater importance under existing social and economic conditions than was the case twenty or thirty years ago when the present system of contract bond rating was created. During these years also the building business particularly, and the heavy engineering field to a lesser extent, have witnessed the growth of the practice of performing construction work by subcontracts until the very great majority of superstructure contracts are today performed almost entirely on a subcontract basis, even by the best contractors.

Revision of the premium rates on contract bonds must also embrace complete overhauling of the present system of classification of different types of contract, particularly if the sureties expect to enlist the cooperation of the building industry and owners and their representatives in adopting the practice of using surety bonds on private construction. Since most contracts of this type involve superstructure work of a comparatively standardized type performed, usually, by subcontractors, it must be recognized that there is a great difference in hazard, as well as financial requirement, between ordinary building contracts and contracts for dams, tunnels, foundations, water work, etc. This difference in hazard and capital needs should be recognized by a differential in rates which should encourage a wider use of surety bonds on private work.

Lower brokerage commission

Compared to other classes of suretyship which produce a comparable volume of premiums, such as the various blanket fidelity bonds, the commissions paid to brokers and agents on contract bonds are excessive and are not justified by the value of services rendered by these brokers whose knowledge of the highly technical subject of corporate suretyship is necessarily limited by their experience in this field. In the past, these excessively high commission rates encouraged the control of bonding business for partisan political advantage and likewise contributed to the equally injurious practice of rebates to persons not legally qualified as brokers or agents. While the soli-

citors of such surety bonds naturally object to any reduction of commissions, they must realize that they cannot continue to refuse to accept on contract bonds the same commission they are perfectly willing to accept on blanket bonds and most classes of casualty insurance. If premium rates are to be drastically revised, then commissions to brokers must likewise be substantially reduced in all cases. To the extent that the bonding of private work extends the use of corporate suretyship, this sacrifice is merely a contribution to an insured income for a greater period than continuance of the present system is likely to produce.

Stricter underwriting practice

The investigation and underwriting of an application for a contract bond should be so scientifically done as actually to amount to what a bond purports to be, i.e., a guarantee that the experience, ability, integrity and financial responsibility of the contractor are all equal to the requirements of the particular contract to be bonded. Present underwriting procedure is to blame for the prejudice of many owners, both public and private, and of architects and engineers to the use of corporate suretyship, and this procedure is also responsible for the fancied need for existing rates and commissions. Too much underwriting "information" is based on gossip and hearsay evidence, instead of on knowledge of the facts which it is the underwriter's duty to obtain at first hand. Underwriters handling accounts for active contractors should inspect the quality of workmanship performed under their contracts which they bond; they should know, by personal contact with the owners and their representatives for whom the contractors work, just what the owner or his representative thinks of the contractor's methods, etc.; and, without exception, surety companies, either individually or through a central bureau, should verify the experience of subcontractors with the general contractor on every contract completed by such general contractor.

No financial statement, except a statement prepared by a certified public accountant, should ever be accepted, and in every such case the surety should require that the C.P.A. certify that he has verified all accounts and retainages receivable, cash in bank, etc., all of which can readily be done by the accountant but, in general practice, is not now done. Honest and conservative contractors are too frequently obliged to compete with less honest and less conservative contractors who, nevertheless, obtain surety bonds, frequently on the basis of false and unverified financial statements which too many surety underwriters accept without intelligent investigation of each item.

One of the most salutary effects of a reduced premium income would be the enforced improvement in the underwriting methods of surety companies, and this is perhaps even more to be desired than a mere economy in the cost of suretyship. If sureties always investigated the experiences of owners and subcontractors with their general contractor clients, they would know beyond reasonable doubt whether these general contractors are honest, capable and financially responsible.

More honest loss adjustments

Until recent years surety companies too seldom realized that the purpose of a surety bond should be to provide protection to the assured against all loss which might result from a contractor's default. One of the most elementary and equitable obligations of a surety should be to guarantee that its principal is at least honest enough to apply the income received from the owner to pay for the work performed by subcontractors or materialmen. A contractor who is not honest enough to meet these obligations is not honest enough to be trusted with a faithful performance of any contract. Owners should be protected by surety companies against the chance that any such individuals may be qualified by a surety bond beyond the responsibility which their personal integrity alone should offer. All surety bonds should guarantee payment of a contractor's obligations and permit the unpaid creditors a direct right of action against the surety which actually becomes a voluntary sponsor for the contractor when its bond is issued.

Having resolved to give the assured a bond which fully protects the assured against loss through the contractor's default, and which properly guarantees the honesty of the contractor and the payment of his obligations to his creditors, the surety companies should then realize that they have an obligation to the beneficiary in the bond whose requirement of a bond is actually the source of their business. The sureties should treat all claimants, whether owners or creditors of the contractors, with a more sensible realization that these claimants are the people on whose goodwill the sureties must alone depend for the continuance, as well as the growth, of the practice of using corporate surety bonds in connection with construction work.

Too often attorneys and claim adjusters for surety companies resort to methods which the underwriters of their companies would severely condemn if practiced by an applicant for their suretyship. If such practices prejudice the reputation of an applicant for a bond, the sureties must realize that similar practices lessen the value of corporate suretyship in the eyes of assureds.

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Sewer Service Charges Surveyed in Cities

Increased interest of cities in sewer rental charges to meet the cost of municipal sewerage service is reported in a survey made by the American Public Works Association. Cities of less than 25,000 population make up the bulk of those now charging sewer rentals, the survey shows. Few of the cities try to derive sufficient funds from rentals to finance all the costs of sewerage service. Some of them use rental revenues to pay the debt service on new treatment plants, while others have turned to rentals to operate existing plants.

Of the 104 cities studied, 42 indicated that revenues were used for administration, operation, maintenance, replacement, debt service, enlargement of existing systems and extension into unsewered areas. Four of the cities use practically the entire amount collected for debt service while 16 cities use no part of such revenue for that purpose and four others, less than 20 per cent.

More than one-third of the cities surveyed base the charge on water consumption as measured by meters. Another third make the number of plumbing fixtures the basis of charge. Other bases include the number of sewer connections, the type of property and metered quantity of sewage. A few small communities use uniform rates, which vary from $3 to $10 a year.

FIG. I. ROADSIDE PARKS IN OHIO ENABLE THE MOTORIST TO REST AND LUNCH AND EVEN COOK HIS LUNCH.

Road Upkeep—A Recreational Service

C. S. HILL

Associate Editor, Engineering News-Record

Contents in Brief—The comfort and pleasure of the tourist, who is one of greatest and most profitable of road users, is a definite objective of modern road maintenance. This fourth article in the series on the services rendered by modern maintenance illustrates examples of recreational service.

TO MAKE the road user's travel a scenic pleasure and to provide places for his comfort and recreation have rapidly become as much a part of road upkeep as is a smoothly kept travel surface. Highway landscaping is now a definite function of maintenance and most state highway departments have landscape architects. Their art, too, ranges far beyond the local garden-club flower beds and plantings of exotic shrubs. Few highway engineers ever relished this plastered-on decoration and with the coming of the trained landscape architect it is passing out and now the expression of this built-up art is found mostly in roadside parks which are still largely local contributions.

Highway landscaping begins with the geometrical design of the road. Its location, alignment, profile and amplitude of cross-section are fundamental elements of highway landscaping. A rolling profile, easy curves, long sight distances, wide traffic lanes and shoulders, flat ditch and side slopes of cut and fill that characterize the latest road design are positive landscaping requirements. But, be it noted, they are quite as positively essential to rapid and safe transport and that is why they have developed. And here is presented the first principle of highway landscaping. It is that the practical utility of the highway must be added to and not subtracted from.

Beauty and recreation

As the highway landscape architect regards this function it is to work with the design and the construction engineer to ensure that the road shall embody every transport utility. Then his duty is to add beauty to practicality in such a way as to increase safety and durability. He plants slopes as shown in Fig. 7 to provide verdure and prevent erosion; he removes roadside trees in one place to reduce the appearance of narrowness of roadway or he preserves them in another place to indicate from a distance the line of road, and in all he seeks to improve appearance. He cuts a jungle growth to let in the sun on a damp surface or to open up a pleasing view as shown by the illustrations Figs. 2-5. Notice that in none of this work is the use of the road restricted; no service to traffic is reduced but beauty is added. This is highway landscaping.

It is important to recognize this distinction of landscaping from gardening. Highway landscaping is the youngest of highway department functions. It came into the field of practical engineering with a handicap; engineers impatient with the local garden club geranium beds had no effusive welcome for the beautifier of any sort and to cap everything, highway landscaping was a new art about which even the professional land-

Fig. 2. The Ohio road at the right presents a pleasing border of roadside trees and shrubs.

Fig. 3. When the landscape architect investigated he found that the bordering growth made a curtain that shut off the view at the left.

Fig. 4. Again, the removal of the roadside growth at the right, giving only a glimpse of water, worked a scenic marvel.

Fig. 5. The broad sweep of river shown at the left emerged and displayed a scarcely suspected distance of view.

Fig. 6. Erosion reduction is quite as much a purpose of roadside planting as is the provision of growing verdure to please the eye.

scape architect himself was rather ignorant. And, of course, the subject was one on which the road user had no thoughts one way or another. Even now he scarcely realizes the great service he receives.

Perhaps the sole disproof of this general statement is offered by the roadside park. These have been created in hundreds and during the summer are used by thousands as a place for rest and to eat, and perhaps cook, a luncheon or a dinner. Roadside parks, picnic areas, turnouts, scenic overlooks, school shelters and in some states information offices are growing elements of the service to recreational travel that modern road upkeep gives.

Economic service

On final count perhaps the greatest service that highway landscaping renders is economic and the largest item of this service is reduction of erosion. The full field of erosion control occupies a border zone between engineering and landscaping, possesses much of both and is too comprehensive to be discussed in detail. One phase of the work, however, in which the engineer freely grants precedence to the landscape expert, is planting. The great part of highway erosion is on the slopes of cuts and fills and on shoulders and ditch banks, and planting is the best means of prevention.

As planting is regarded in highway landscaping it is something quite different from the garden-club work abhorred by maintenance engineers; it has the definite duty of protecting the soil from the wash that is the greatest expense in the long run of road upkeep. That it adds the beauty of grass and shrub and vine is merely a supplementary service. But this plant growth is a kind that is native to the countryside and because of this will take root and flourish. Exotic planting has no place in this rational program.

In discussing highway landscaping Julian Montgomery, state highway engineer of Texas, one of the states that have landscape architects, says: "Beyond doubt landscaping for the preservation of roadsides, promotion of safety and conservation of soil is the final touch to a well-rounded highway system. It justifies itself on the basis of economy alone."

Conclusion

Artistic pleasure gives way to enjoyment of the spectacular in the service of road upkeep described in the next article. A spectacle beyond every other activity of maintenance is offered by the winter fight against snow blockade.

Fig. 7. A spot map of the roadside parks of Ohio as of 1938; every year sees the number increased.

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Efflorescence on Brickwork

The troublesome and unsightly feature of salt efflorescence on brick masonry may originate from the bricks or the mortar, or both; and the soluble salts in bricks may originate from the raw materials (clay or shale), from the water used or from kiln gases, according to the National Bureau of Standards. A study of 638 samples of bricks from 219 manufacturers led to the following conclusions:

Liability to efflorescence is less for hard-burned brick than for underfired brick. No significant difference in tendency to efflorescence is found in bricks made from clay, shale and fire clay. The method of forming (by dry press, soft mud, side cut or end cut process) seemed to have no relation to such tendency.

Weighted distribution of the data in relation to tendency to efflorescence is as follows: 85 per cent less than "moderate", 10.9 "moderate," and 4.1 exceeding "moderate." For the samples classed by the manufacturers as hard-burned (94.1 per cent of the total samples), the corresponding figures are 86, 10.4 and 3.6 per cent. For the samples classed as "salmon brick" by the manufacturers (or 5.9 per cent of the total), the figures are 67.8, 19.0 and 13.2 per cent, respectively.

Old Rails Hold Fill Slopes

Southern Pacific Co. uses old rails to form protective jetties and to anchor bank revetment

OLD RAILS ARE USED effectively by the Southern Pacific Co. to protect its track and fills from injury by the swift waters in some of the stream canyons through which it operates. Two uses are shown in the accompanying pictures. In one case the rails are used to form a permeable revetment, and in the other the rails reinforce and anchor a concrete slab revetment.

Old rails used for bank protection by Southern Pacific Co. (Top) Rails driven along toe of slope are bent over to form reinforcement for concrete revetment. (Below) Open fence of old rails and netting check erosion of slope.

For the permeable revetment, rocks of the largest size that can be handled conveniently are placed at the base of the railroad embankment and in a trench 5 ft. or more deep at the toe. Just outside this trench a row of old 75- and 90-lb. rails is driven vertically to well below the scour line, leaving about 10 ft. of each rail projecting above the ground surface like fence posts. On the fill side of the trench and about 5 ft. back of every third post, other rails are driven with their tops about 4 ft. lower than those in the front row. Lighter rails used as struts extend from these deadmen to the outer row of posts, all being securely welded. Heavy galvanized netting is fastened to the outer row of posts with tie-wires and U-bolts. In locations where the current is strong, five runs of old steel cable are strung along the face of the fence being clipped over railroad spikes welded to the rail flange, the spike subsequently being bent over the cable to hold it in place. Finally, a trench is dug about 3 ft. deep along the outer side of the fence posts and three runs of 3x12-in. creosoted planks are put in to make a tight diaphragm to check the movement of fine material through the fill.

The advantage of this type of protection is that it forms a well braced support for the rock in the toe of the slope, and by slightly cutting the rate of flow of the water that passes through the fence during flood periods causes the deposit of fine materials carried along in the current, thus checking erosion.

For the concrete revetment, old 75-lb. rails are driven on 4-ft. centers to a depth below probable scour along the toe of slope, the rails being driven with the head toward the fill. Then a cutting torch is used to cut away a section of the web and flange close to the ground and the rails are bent down to the slope of the fill. Wire mesh fastened to the underside of the rails in the slope plane serves as a retainer against which material from the slope can be worked down until a uniform grade is formed. On this the concrete mat is poured, embedding both the mesh and the rails.

Both types of bank protection have been developed under the direction of W. H. Kirkbride, chief engineer, Southern Pacific Co.

Protective Coating for Concrete Placed in Forms Before Pouring

Salt water attacks on under sides of wharves in San Francisco Bay prevented by pre-treatment of beam and slab surfaces

AFTER EXPERIMENTING with various forms of protective coatings applied to the under side of concrete wharves, the Board of State Harbor Commissioners for San Francisco Bay has developed a coating which is put in place before the concrete is poured. Thus there is a saving in cost and increased efficiency as compared to treating the under sides of the wharves after construction is finished. Some form of protection for the concrete is desirable because of the continued presence of salt-water vapor under the wharves. Even minute cracks or defects in the concrete cause rusting of the reinforcing with consequent spalling of the overlying concrete, in time leaving the steel exposed.

Membrane laid in forms

The protective coating now standard practice for new piers at San Francisco is a waterproof membrane laid on the forms after the carpenters have completed their work and before the steel reinforcing is put in place. It consists of a layer of heavy building paper with an asphalt coating on the upper surface. Care is taken not to fasten the membrane to the forms, but rather to merely lay it upon them.

The next step is to mop on a thick coating of asphalt and while this is still hot, clean pea gravel is scattered over the surface with shovels. Particular care is taken to make sure that there is no dust in the gravel. After the surface has cooled thoroughly and just before pouring concrete, the excess gravel, i.e., all that has not adhered to the hot asphalt, is swept off.

It is important to put the protective membrane on all exposed sides of beams; hence, to avoid the difficulty of applying hot asphalt to vertical surfaces, the membrane for the sides of the beams is mopped and sprinkled with gravel while lying flat. After the asphalt has cooled, the membrane strips are slid into place in the beam forms. (On hot days the vertical asphalt surfaces may require sprinkling to prevent sloughing.) Reinforcing steel then is placed and concrete is poured.

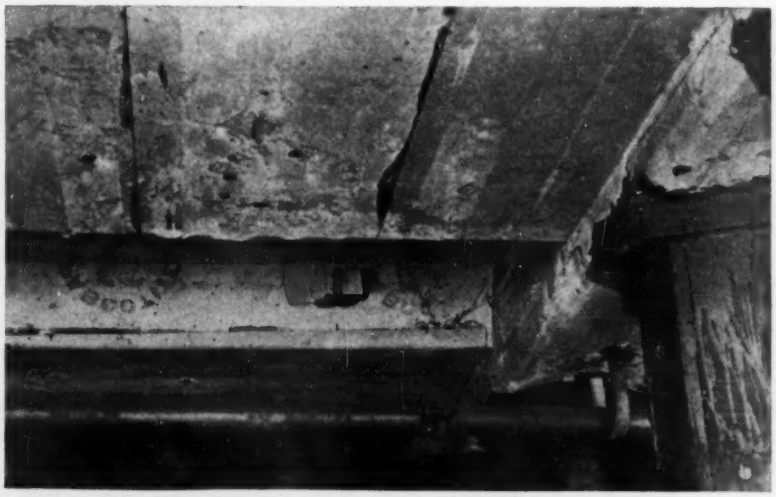

Fig. 2. After many years of service underneath the floor system, the membrane can be seen to be uniformly tight and still giving effective protection.

Fig. 1. Waterproof membrane in place on forms, ready to be bonded into the concrete surface. The membrane is laid before the reinforcing steel is put in place.

Coating seals any cracks

Under heavy loads, the floorbeams may deflect enough to open small cracks in the concrete between outer surface and steel reinforcing. These cracks are not serious in themselves but if they admit salt vapor corrosion of the steel with serious consequence is likely. Under the protection of an asphalt membrane, however, even if cracks occur in the concrete, there is enough resiliency in the asphalt to maintain a coating tight enough to exclude water vapor. Since such a membrane has been in use along the San Francisco waterfront, trouble with disintegration of concrete on the under side of beams has

been practically eliminated.

This good record in part may be credited to the fact that practically all San Francisco piers are roofed, thus rain water does not collect on the floors. Where pier floors are exposed to the weather, and if shrinkage cracks occur, seepage through the cracks has been known to form blisters where it accumulates between the concrete and the membrane.

Precautionary measures

Particular attention to three elements is recommended to insure success in the use of this protective coating; (1) clean gravel must be used because the presence of dust, sand. etc., would prevent bond; (2) excess gravel must be carefully removed by brushing and then an air jet must be used to blow out all dust so that there remains a clean surface with projections bonded to the asphalt, and (3) quality of concrete and pouring methods must be such as to develop bond between the concrete and the protective membrane. (If the mix is too wet or too dry adequate bond will not be made between gravel, membrane and concrete.) Where these precautionary measures are observed it has been found that the membrane will not strip off when the forms are removed.

Materials required

Various materials may be used for the membrane. When coated with asphalt the thickness is $\frac{3}{8}$ to $\frac{1}{2}$ in. Materials used per square are 60 lb. of asphalt (40 penetration, 150 deg. F. melting point) about 2 cu. ft. of gravel ($\frac{1}{4}$- to $\frac{1}{2}$-in. mesh) and 100 sq. ft. of heavy building paper. This membrane makes the forms tight despite cracks and knot holes, thus permitting the use of lower grade lumber and obviating much care in form building. The resultant savings on formwork are said nearly to offset the cost of the membrane.

The fundamental principle of the method described has been used on the San Francisco waterfront for more than 15 years. Frank G. White, chief engineer, Board of State Harbor Commissioners, gives credit for development of the method to its present advanced stage to I. G. Webb, construction engineer.

Steel Rigid Frame Design Used for High School

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A NEW ADDITION to the Washington High School in East Chicago, Ind., is framed with steel bents designed as rigid frames, an uncommon practice in steel construction. The bents are two spans wide and three stories high, the beams being made continuous, the joints marked *P* in the accompanying illustration being figured as partly restrained and those marked *C* being figured as wholly rigid. The floors were designed for 100 lb. per sq. ft. live load.

Continuity reduces girder depth

Center column connections were assumed hinged top and bottom, an assumption held justified because of the small rigidity of the 10-in.-*H* center columns compared with that of the girders which are 21-in. wide-flange sections with cover plates. The end columns are 16-in. *H*'s with cover plates. Shop connections were welded and all field connections were riveted as shown in the isometric view below.

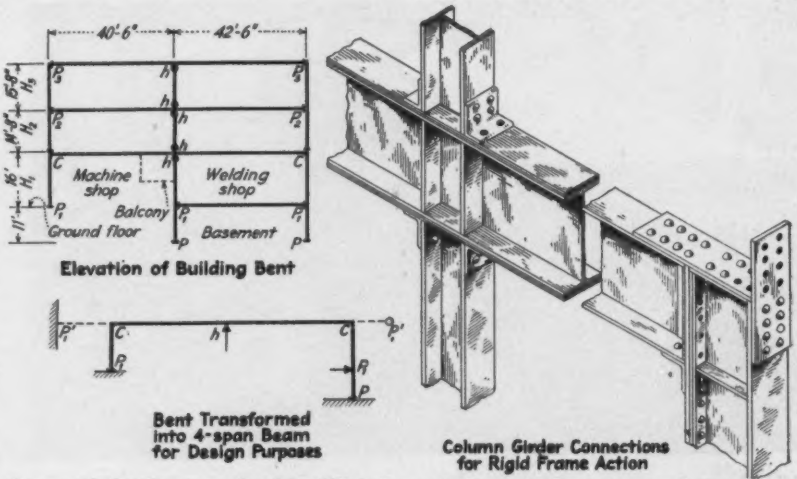
It is to be noted that if the beams had been designed as simple spans, 27-in. instead of 21-in. sections would have been required to avoid excessive deflection. By designing and building the bents as rigid frames, a useful saving in clear height and a more rigid floor system were obtained.

Design procedure

The structure was analyzed by the theorem of three moments. In view of the favorable dimensions of the building, the solid concrete floor system was assumed to transmit side sway and wind load to the cross walls so that these forces did not have to be considered.

In figuring the lower-story frame P_1ChCP, a four-span beam with ends partly restrained (that is, with the two end columns stretched into horizontal position as shown in the accompanying illustration) was assumed. After the moments for the corners *C* were found they were distributed to the upper and lower columns in proportion to their respective rigidities. The points of inflection for the columns were assumed at $\frac{H_1}{4}$ near P_1, at $\frac{H_2}{2}$ for the second story and at $\frac{H_3}{4}$ near P_3. An unusually simple detail was worked out for the fully rigid corner *C*.

The steelwork for the school building was furnished and erected by Joseph T. Ryerson & Sons, Inc., from designs prepared by the writer.



Structural details of a school building frame designed with continuous beams and rigid connections.

Spiraling Circular Curves For High-Speed Trains

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***Contents in Brief**—A method for adding spirals to curves in railroad tracks without requiring excessive throws in the track is outlined, using a typical example to demonstrate the method.*

THE ADVENT of high-speed trains has brought with it the need for much better track alignment and the addition of spirals to all curves not already spiraled. But unless the spiraling is done skilfully it will result in excessive throws in the curve that will make trouble for the track maintenance forces.

In the following, a method is outlined that has the advantage of not producing large throws. Further, being a transit method, it can be reproduced at a future date without the solution of another problem, as is necessary with string lining. It is especially useful on roads that do not yet permit string lining and on roads that limit the amount that track can be thrown in realignment work.

For practical reasons, track throws should be held to a minimum with in-throws and out-throws balanced to eliminate tight joints and the necessity of cutting rails. It is therefore necessary to increase the degree of a circular curve in order that a proposed curve with spirals at its ends will have an out-throw at its center approximately equal to the in-throw necessary at its ends to allow for the spirals.

The problem given is simple but quite common, the computations being those of an actual job. Spiral tables of the American Railway Engineering Assn. are used and the nomenclature is as follows:

P.I. = Point of intersection of true tangents, to be connected by circular curve having spirals at each end.

T.S. = End of true tangent and beginning of spiral.

S.C. = End of spiral and beginning circular curve.

C.S. = End of circular curve and beginning of spiral.

S.T. = End of spiral and beginning of true tangent.

T_s = True tangent distance from P.I. to extreme end of spiral.

T_c = Tangent distance for given circular curve and central angle.

A = Point on circular curve, produced, at which a tangent to the curve becomes parallel to true tangent.

p = Distance between true tangent line and parallel tangent to circular curve.

q = Distance along true tangent from T.S. to point opposite point A. (q is approximately one-half the length of spiral.)

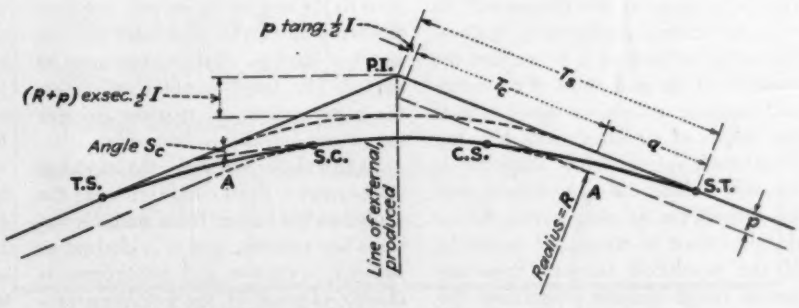
The problem is to spiral a one-degree circular curve for a speed of 85 mph. The recorded central angle is given as 18 deg. 50 min. Theoretical determination of the superelevation gives 4¾ in. Assuming an allowed unbalancing of 2¼ in. in superelevation, the practical superelevation becomes 2½ in.

A speed of 85 mph = 125 ft. per sec. Allowing a rate of change in elevation of 1¼ in. per second, a spiral length of 250 ft. is desired $\left(\frac{2.5}{1.25} \times 125 = 250\right)$.

The P.I. was determined in the field and the original central angle checked at 18 deg. 50 min. In establishing tangent lines, it is important not to let the tangent at the ends of the curve influence the setting of the transit. The apparent tangents at ends of curves are invariably out of true line, and should not be permitted to influence the preliminary work. Generally speaking, established tangents 600 to 1,000 ft. long, with one control point at least 300 ft. from the apparent end of the curve will produce good results in determining an accurate central angle. These may be considered minimum requirements.

With the transit at the P.I. and the central angle measured, the transit was turned along the line of the external to the curve and the actual external distance measured in the field. It was found to be 78.47 ft. This distance should be measured carefully as its use in calculating throws is important. By use of this external distance and the formula: $E = R$ exsecant $1/2\ I$, the degree of the existing curve was found to be about 0 deg. 59 min. 50 sec. All data are now available to make calculations for the spiral curve. Incidentally, the field work to this point is the same as would be required for rerunning a circular curve.

A study of the maximum possible throws should now be made by inspection of existing clearances to any permanent obstruction, and to shoulder widths. In the problem being discussed, the P.I. and external line were fifteen feet north of the north edge of a concrete-slab grade crossing. The slot in the pavement slab was such that a maximum out-throw of 0.1 ft. could be made without having to alter the slab or compound the curve to fit the crossing. This throw was therefore accepted as the maximum that could be permitted at the center of the curve. Calculations for the curve were made accordingly.



Method of adding spirals to a circular curve in railroad track.

Knowing that the approximate degree of the existing curve at its center was 0 deg. 59 min. 50 sec., external distances for a curve some few seconds sharper were computed until the desired out-throw was obtained. Generally speaking, the longer a circular curve, the less increase in degree will be required for a given outward throw. In this case increases of 30 sec. in degree were tried until a satisfactory external distance resulted. With a little experience, not more than two or three trials will be necessary. For brevity, only the calculations for the chosen curve will be detailed.

Trial calculations for a curve of 1 deg. 00 min. 17 sec. with a spiral length of 250 ft. at each end result in an external distance equal to 78.37 ft. Hence, an out-throw of 0.1 ft. is obtained for the center of the curve. The formula for the external distance to a simple curve with equal spirals at each end is: External $E = (R + p)$ exsecant $1/2\ I + p$. The value p was taken from spiral tables, interpolated for the given degree of curve. The following values are also taken from A.R.E.A. spiral tables: $S_c = 1.256$ deg.; $q = 125.0$ ft.; $p = 0.46$ ft.

Reference to the sketch shows that the tangent distance T_s is the sum of the distance T_c, q, and p tangent $1/2\ I$. T_c, calculated or interpolated from tables, equals 945.48 ft. The value q given above is 125.0 ft. The value of p tangent $1/2I$ is 0.08 feet. T_s, therefore, equals 1,070.56 ft.

Deflection angles for 250 ft. ten-chord spiral with an S_c of 1.256 deg., were interpolated from spiral tables. The calculations for but half of the circular curves are sufficient for staking out the entire curve and afford an exact check on all the work.

The first step in staking the curve is to set the stake at the middle of the curve by use of the calculated external distance. Location of the T.S. and S.T. can be accomplished in two ways. One is to measure the distance T_s in each direction along the tangent lines. The other procedure is to start at the stake set at the mid-point of the curve and measure a distance equal to half the length of circular curve plus the length of spiral. This distance is measured along the approximate center line of the existing curve. Either distance must be measured carefully. If the produced tangent lines are across rough ground, requiring frequent breaking of chain, measuring along the center of the existing track will produce more accurate results.

With the T.S. and S.T. points established, stake one of the spirals, starting at either end of the curve. Next move the transit to the S.C. thus established and turn tangent to the spiral at that point. Next, turn the calculated deflection angle to the mid-point of the curve. If the calculations and field work are correct, this line of sight should check on the stake previously set by use of the calculated external distance. If this check is not within the desired limits of accuracy, either the calculations are in error, or the field work needs checking. The writer's experience has been that a tolerance of 0.2 ft. in checking on the center stake can be obtained on curves up to 2,500 ft. in length. However, this method of check is dependent upon a back sight whose length is equal to the length of the spiral. If short spirals and long curves are involved, allowance in closure must be made for the relative difference in length of the back and foresights. If a satisfactory check is not obtained at this point in the field work and the T.S. was set by measuring along the produced tangents, measure along the center line of the existing track from the S.C. to the mid-point stake. This distance should check the calculated value for half the length of circular curve. This additional check should indicate whether the suspected error is in calculation of deflection angles or in the distance T_s.

Assume that a reasonable check is secured on the sight to the mid-point of the curve from the S.C., though actual closure is not obtained. The error of closure should be compensated for in the circular curve and not in the spirals. Therefore, the circular curve may be backed in from the mid-point by an initial sight on that point with correct deflection angle. The circular curve may also be started from the S.C. by turning tangent to the end of the spiral, and then throwing any error of closure into the last few stations of the curve near its center. The latter method represents the better practice in that the circular curve and spiral join correctly.

In the above example, throws were set to meet a fixed condition near the center of the curve. If no such limitations are present, and it is desired to balance in-throws and out-throws as closely as possible, the following procedure is recommended.

If the existing curve alignment is not bad, introduction of a spiral will produce an in-throw at the S.C. and C.S. which will probably be the maximum found along the curve. These in-throws will be approximately equal to the value of p required for a given length of spiral and degree of curve. Consequently an out-throw at the center of the curve approximating the value of p is desirable. In practice, in-throws as large as the value of p will seldom be obtained at the S.C. and C.S. due to rough spirals introduced by traffic and track maintenance forces. Therefore, calculated out-throws for the center of a curve may be made slightly less than the value of p.

Any high degree of accuracy in calculations may be nullified by careless work in the field. Center stakes should be carefully set, with transit sights kept at reasonable lengths. The tangent lines and beginning and ends of spirals should be permanently marked. The P.I. should also be monumented or referenced so that it may be reproduced.

Track forces should be required to use care in lining curves to stakes. It may be shown mathematically that slight variations in alignment to stakes which are set relatively close together may produce increased degree of curvature requiring superelevation in excess of that provided. This factor is particularly important at high train speeds and with actual superelevation in the track unbalanced by several inches over its theoretical amount.

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Earthquake Sounds Studied

Observation of sounds generated in deep wells near known major earthquake faults in California, begun about a year ago (*ENR*, April 28, 1938, p. 626), is at present going on on a modified scale. The observing station at Mills College was discontinued in March because much of the apparatus was borrowed and had to be returned to one of the Coast and Geodetic Survey parties leaving for Alaska. The station at the Alameda County Zoological Gardens, however, is still in operation. Both stations are near the Hayward fault. If means can be found to extend this acoustic work to other regions, so as to cover other geological conditions, this may be done.

ENGINEERING NEWS-RECORD

SPECIAL WATERWORKS SECTION

June 8, 1939

ACTIVITY in the field of water supply is booming as it never has before. Measured by money spent for new construction as well as by progress in technical developments, the industry has entered a new era of accomplishment. Just to high-spot the construction activity, for example, 80 million dollars of construction were awarded in the first three months of the year, which is 60 per cent of the 12 months' volume of 1938, an all-time record year. This year's annual waterworks number is therefore of special significance.

What is behind this accelerated pace in waterworks activity? Undeniably much of the stimulation comes from the availability of federal funds. But it takes more than federal money to create the need for expansion and improvement of public water supplies. The fact is that we have entered a period wherein major water systems built some three decades ago have become obsolete or inadequate, and in which numerous small communities that heretofore had no public supply have decided en masse in favor of one.

BEHIND ALL PLANS for improvement lies the compelling desire to produce better service at lower cost. And to this end technical advances are constantly being made. In the purification process research chemists have seemingly solved former vagaries of coagulation and sedimentation so that the engineer designers now have complete confidence that water of uniform pre-treatment will reach the filters. The 6-to-8-hr. standard sedimentation period once considered orthodox is now halved in the newer designs, exemplified by those projected for Chicago and Toledo. Acid-treated sodium silicate is the latest addition to the long list of chemicals on which the operator may depend to secure better coagulation. Thus, cooperation between chemist, operator and engineer makes it possible for the designer to achieve new standards of reliability.

Short filter runs, the former bugbear of the operator, can now be controlled by varying the coagulant used. This means that the designer must pay heed to flexibility and provide adequate facilities for quick changes. The acceptance of the necessity for keeping filter sand clean by the use of surface wash, despite some differences of opinion as to details, has been a stabilizing influence. Based on the broad experience of operating men coupled with laboratory research on the particular water to be treated, every plant may now be said to be custom built for the water it handles. Filters are therefor a long way from being a "shelf hardware" product and their design calls for the ingenuity of the engineer to convert the requirements of chemist and bacteriologist into an efficient mechanism.

ARTICLES in this special section are focussed on progress in the art. Special importance is attached to a description of Baltimore's newest automatic pumping station in view of the trend today toward wider use of supervisory control systems. The reason why cities along the Great Lakes are pushing intakes out into those inexhaustible reservoirs to replace less desirable sources of supply is explained, and of particular interest is the clever solution of a peak load distribution problem in Denver. These and additional thought-provoking articles provide new information leading to better waterworks design and operation.

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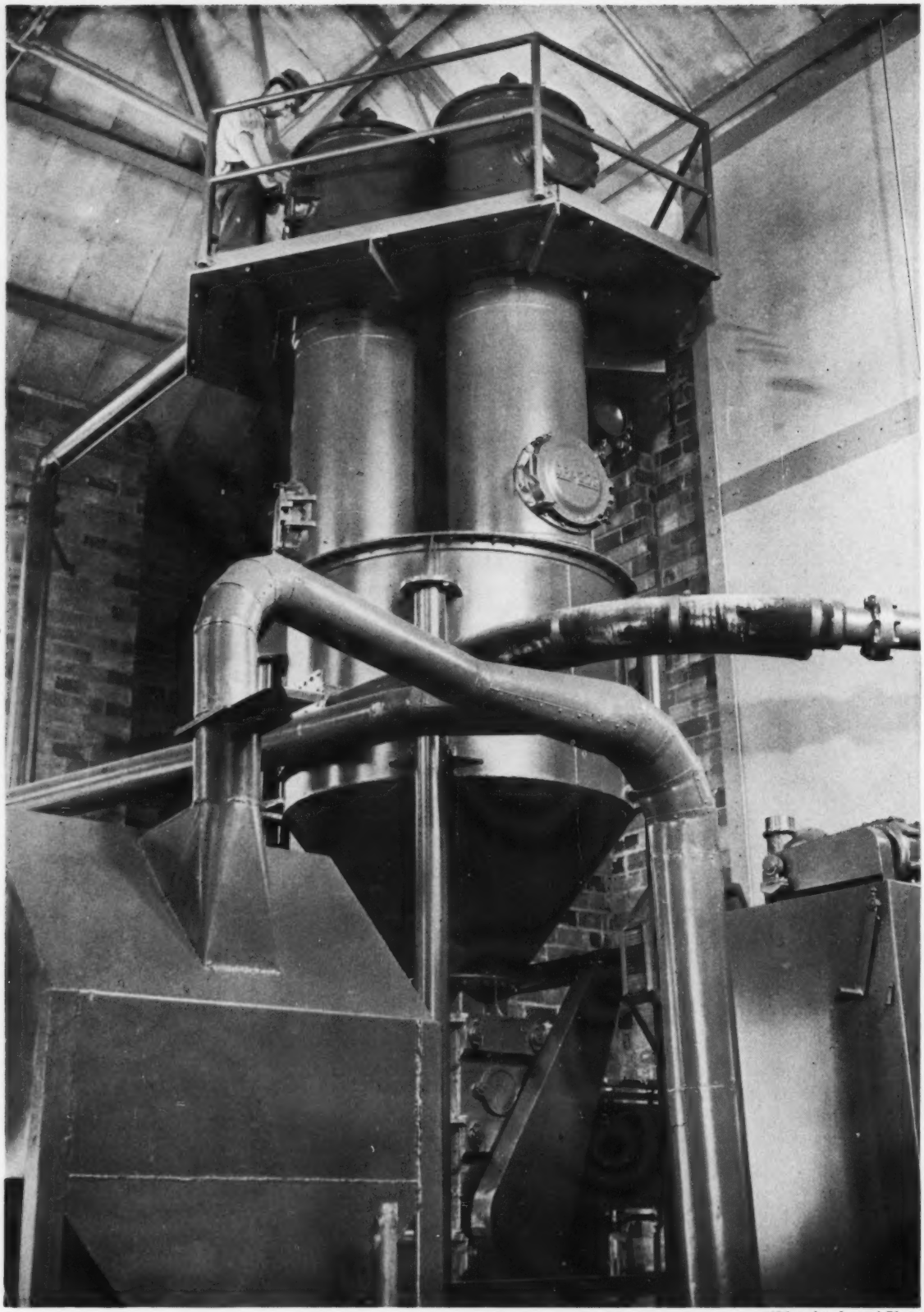


Milwaukee Journal Photo

Pneumatic conveyor system for chemical handling in the recently completed Milwaukee water filtration plant.

New Jersey—Birthplace of the Filter

M. N. BAKER

Associate Editor, Engineering News-Record, (Retired), Upper Montclair, N. J.

Contents in Brief *— Present-day practice in mechanical water filtration and coagulation had its beginnings in New Jersey sixty years ago. M. N. Baker, dean of American writers on water supply, sketches the history of this significant development in water purification.*

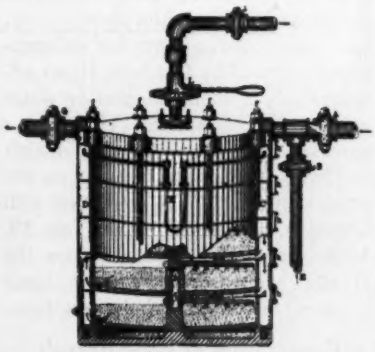
NEW JERSEY was the birthplace and fostered the development of the American mechanical water filter. In a crude way the water filter took form at Rahway under the hand of Patrick Clark. Adapted and improved by John Wesley Hyatt it assumed a new mechanical form at Somerville and later was combined with the coagulation process of Isaiah Smith Hyatt. Then with further mechanical changes by J. W. Hyatt it was installed at Long Branch. All this occurred in the decade ending with 1888. Fourteen years later, a radically different mechanical or rapid filtration plant designed by George W. Fuller was put in operation at Little Falls.

Although the essential feature that gave mechanical filtration its name had been anticipated and to a limited extent utilized long before the days of Clark and the Hyatts, they were probably blissfully unaware of it. None of these anticipations included coagulation, which was to make mechanical filtration a success and warrant the name rapid in contrast to slow sand filtration.

Clark's jet wash

Called on in March, 1876, to find a remedy for the "almost constant turbid condition" of the water supply of Rahway, Patrick Clark, the city engineer, reported that instead of furnishing "spring water" from an infiltration basin built in 1871, a large part of the supply was drawn from the North Branch of the Rahway River, made turbid by every rain. He advised the construction of "a large settling reservoir and filtering apparatus." The board engaged for this purpose George H. Bailey, who designed filter basins for Newark and Rahway. Almost immediately, the water board abandoned the project.

Clark became chief engineer of the Rahway Water Board on May 8, 1878. On October 21, 1880, he resigned his position and the board voted "that the filter constructed by P. Clark at the works be allowed to remain there." When and under what conditions it was put in, its nature and how long it remained in service is unknown. In a special report of the Tenth Census of the United States, transmitted to the director on June 1, 1882, these words appear in a description of the Rahway waterworks: "Filtering Apparatus: Clark filter, 16 ft. sq.; sand, 6 in. deep on fine wire cloth; cleaned once in 24 hours. Consumption, 0.5 mgd." This indicates a filtration rate of 85 mgd per acre.



The Hyatt filter illustrated in *Engineering News* of January, 1882.

Evolution of Hyatt's filter

Four days before his resignation, Clark applied for a patent on his filter. On Feb. 11 following, John Wesley Hyatt applied for a patent, virtually embodying Clark's design. Both applications, assigned to the Newark Filtering Co., were granted June 21, 1881.

Rahway was only a few miles from Newark, where John Hyatt and his brother Isaiah had a flourishing business as manufacturers of celluloid. It may be assumed that Hyatt saw Clark's filter at Rahway and set his inventive mind on its exploitation. His patent of June 21 was the first of 65 filter patents taken out by him in the period 1881–89.

Clark's patent claims were confined to cleansing filter surfaces by jets of water discharged from the underside of perforated revolving pipe, with outer ends closed. His filter bed was a layer of sand only 3 to 6 in. thick supported on wire cloth. Hyatt converted Clark's filter from an open gravity to a closed pressure apparatus and superimposed any desired number of filters within a single tank. Each filter was independent of the other in action. As described and illustrated in *Engineering News*, Jan. 7, 1882, p. 3, the Hyatt filter had these advantages: economy of space; sand washed in place; any filter could be washed while the others were in use.

Alert for a customer, Hyatt noted that the Somerville Water Co. was building works to supply Somerville and Raritan, a few miles from Newark, and that the supply was to be taken from the Raritan River, made turbid and colored by its red shale gathering area. The minutes of the water company for Aug. 25, 1881, state that Messrs. Hyatt & Co. (Newark Filtering Co.) proposed to furnish four filters, height 8 ft., diameter 50 in.; to stand a pressure of 300 lb. per square inch, for $2,500. The offer was accepted, but subject to a guarantee of satisfactory operation for one year. Subsequent agreements reduced the guarantee period first to six months, then to three months, and stipulated that each of the four main tanks should contain 20 in. depth of sand and the whole plant should have a capacity of 350 gal. a minute (0.5 mgd). On Oct. 20, 1882, the directors voted to pay $1,000 on account of the purchase price of the filters, with the proviso that "if

upon further trial (since they have just been perfected), it is found that they do not work to the satisfaction of the board, the $1,000 is to be returned and the filters taken out." The "further trial" must have been satisfactory for on Dec. 11, 1882, final payment was authorized.

Ejector wash and coagulation

The next stages in the evolution of the Hyatt filter were the substitution of upward-lateral for downward filtration and upward-ejector for downward-jet surface wash, combined with coagulation. After this combination became an assured success the Hyatts sought to introduce it at Somerville. On March 23, 1885, they proposed to furnish the water company with four new filters for $7,000. The company invited proposals from other filter manufacturers. Only one was received. The Crocker Filtering Co. offered to put in two of its "largest filtering machines" for $5,000. What their nature was, is not known.

Next, the Newark Filtering Co. was asked its terms for four of its "improved filters." These proved to be $6,500, less $2,500 for the existing filters. On May 23, the water company ordered "four Hyatt filters, 6½ ft. in diameter by 13 ft. high, capable of standing an internal pressure of 150 lb. per sq. in.; and *accompanied by a suitable coagulating apparatus.* [Italics mine.] They must be guaranteed to deliver 0.5 mgd of "bright, clear and wholesome water for 24 hours if washed once each day." They were to be subject to a service test "after the river water had been muddy for ten days."

On Aug. 17, 1885, the water company authorized a part payment of $2,000 on "the new filters just put in," to be a loan in case the filters, "after use," did not "come up to the terms of the contract." On Sept. 7, the water company accepted an offer to allow the old filters to remain in place provided the filter company was paid the second $2,000 that would be due when the plant was accepted.

The second filters had little in common with the first except that both worked under direct pumping. In the new filters each of the tall tanks was in two compartments, the lower containing the filtering material. Raw water was admitted at the bottom, rose, and, curving outward, passed through an inner perforated cylinder to a concentric clear-water chamber. In washing, the sand was ejected by a reverse flow of water into the upper compartment from which the dirty water overflowed into a waste trough. Finally, the sand was let fall down into the filter compartment. In general principle, this washing system was similar to that of the drifting sand filters built thirty years later at Toronto, Ont.

Genesis of coagulation

After J. W. Hyatt patented his new mechanical apparatus in 1883 his older brother, Isaiah Smith Hyatt, went to New Orleans as sales agent. Unable to cope with the muddy Mississippi River water for the supply of an industrial plant, he adopted a suggestion made by Col. L. H. Gardner, superintendent of the New Orleans Water Works Co., who had been experimenting with sedimentation aided by perchloride or iron; but instead of the hours for sedimentation allowed by Gardner, Hyatt admitted the agent to the muddy water as it entered his filter. This was a success. On Sept. 20, 1883, Isaiah S. Hyatt applied for a patent on the process of coagulation combined with filtration. This was granted Feb. 19, 1884, more than a year before the Hyatts proposed to replace their original filters with their new type.

Pre-aeration at Long Branch

In New Jersey, the Hyatts' next innovations were pre-aeration, a change in filter media and sand agitators. These were introduced at Long Branch in 1888. Waterworks for that famous summer resort had been built by a private company in 1877. The supply was from "springs and a small creek . . . somewhat discolored, especially in the season of greatest demand." (*Engineering News,* Oct. 13, 1888, p. 280). This water, gathered in a small pond, was aerated by discharging it down a 16-in. pipe sunk 100 ft. in the ground. A vertical partition divided the pipe from top to bottom. Raw water fell down one compartment to the bottom, sucking in air, rose up the other side and went to the pump well. Alum was applied to the water on its way to the filters. The filtering media was "prepared coke" and sand, in the ratio of 3 to 1. Sand agitators on a revolving vertical shaft were used.

Aeration by other means than a pipe sunk in the earth became a feature of iron-removal plants. First of these in America was the one completed at Atlantic Highlands, N. J., in October, 1893. It was followed in 1895 by plants at Asbury Park and Keyport. Today New Jersey has twenty-five iron-removal plants on municipal water supplies, most of which include some type of filter.

Although mechanical filters multiplied rapidly after 1887, most of them were on small supplies until many years had passed. Conflicting claims of rival manufacturers, questions of bacterial efficiency and the best methods of design and operation led to experimental tests on various makes of filters, sometimes parallel with tests of slow sand filters. Early and most notable of these were the experiments on mechanical filters at Louisville, accompanied by studies of coagulation and sedimentation, made by George W. Fuller.

Fuller's classic report on the Louisville experiments was published in 1898 but it was not until 1902 that its lessons were embodied in a permanent plant—located in New Jersey instead of Kentucky. It was designed by Fuller and built by the East Jersey Water Co. at Little Falls on the Passaic River above Paterson. Its primary object was the removal of bacteria. In place of cylindrical tanks of wood or steel, rectangular tanks of concrete were employed. Most revolutionary of all its features was pre-coagulation instead of instantaneous coagulation. This was not to avoid the Hyatt patent which had expired in 1901, but because the Louisville experiments showed the importance of giving coagulants adequate time to act before the water entered the filters. The Hyatt patent had been upheld in a long court battle during which bitter competition had crippled more than one company, including the original holders of the Hyatt patent.

The Louisville experiments and the application of their results at Little Falls established rapid filtration on an engineering basis. With the advent of chlorination, first applied in 1908 to a municipal supply, mechanical filtration forged ahead. Subsequently it led and finally almost displaced slow sand filtration in America. Such was the outcome of its modest beginnings sixty years ago in New Jersey.

Perfection In Automatic Pumping

LEON SMALL
Water Engineer, Baltimore Bureau of Water Supply

Contents in Brief — Pioneer and specialist in the application of automatic control systems to pumping, the Baltimore Bureau of Water Supply recently completed a new station in which is embodied the accumulated experience of 25 years' practice. Located entirely underground, the Pleasant Hill station operates itself through ingenious controls and supervisory devices. To insure positive operation of these delicate controls the humidity of the pump room is kept constant with air-conditioning equipment. (See also ENR, May 28, 1936, p. 757.)

A QUARTER-CENTURY of experience in automatic pumping station design at Baltimore culminated in the completion of the Pleasant Hill station last September. Here can be found perfected automatic and supervisory controls whose origin dates back to simple controls first introduced in the pumping station at the Montebello filter plant built in 1914. Developments in this period have been beset by many pitfalls, the rules for the avoidance of which were not to be found in a guide book. This is an account of some experiences and the manner in which they influenced the design of Baltimore's newest pumping station.

What has been accomplished in automatic control found first expression in a pump discharge control system at Montebello where electrically driven pumps were first used. By means of mechanical and hydraulic devices the water level of a spilling chamber receiving the pump discharge was governed, through progressive step throttling of the discharge valves, to control the output of the station. Despite the lack of complete success of this rate control arrangement, principally due to "hunting" of the valves, this attempt at automatic control was significant.

A short time later, in 1915, an old steam pumping plant was replaced with an electrically-driven station. For this, a full automatic control method was devised, using mechanical and electrical devices totally new in the field of pumping plant design in Baltimore. Again the results were not satisfactory, principally due to the failure of the discharge head variations (that were relied upon in the control scheme to govern the operation of the pumps) to be truly representative of the high and low level in the storage standpipes. This caused erratic pump performance, with the equipment starting and stopping in a staccato manner that bore no reasonable relation to water consumption. Furthermore, it resulted in water hammer effects which increased system maintenance.

After these unsatisfactory results, nothing further was done until 1922 when a substantial increase in the capacity of the last-mentioned station, including the substitution of a reservoir for standpipe storage, required that automatic means be developed to control the reservoir water level and indicate this information at the pumping station. To meet this need, an altitude control valve installation was made in the pumpline at the new reservoir. This was arranged to close when the full-reservoir level was reached, and a bypass connection permitted water to flow from the reservoir when the valve was closed and the pump stopped; a signal for this was sounded at the station through an increase in the discharge pressure that followed the closure of the reservoir valve. Contrary to previous ventures, this arrangement functioned almost perfectly from the start. Its performance record was so good and was so consistently duplicated by like installations that followed it, that the general scheme has been adopted for initiating the shut-down cycle of all the automatically controlled pumping stations in Baltimore.

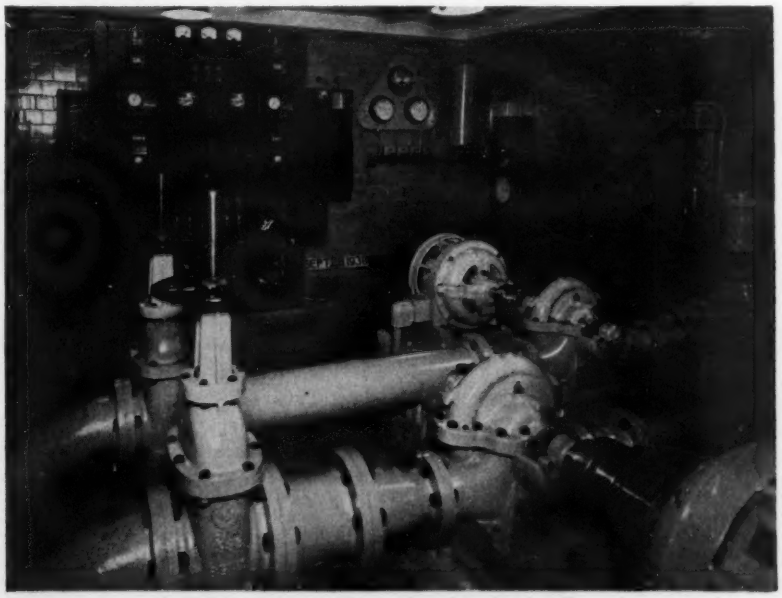


Fig. 1. Automatically controlled pumping station at Pleasant Hill. Located in an underground vault, it is completely insulated and humidity is controlled with air-conditioning equipment.

Success of the pump shut-down control method through altitude valve closure at point of storage gave impetus to the quest for a dependable full automatic control method, and in 1926 the opportunity came to build the first of a series of completely automatic and unattended underground pumping stations. In the last twelve years three similar underground automatic pumping plants have been built and in addition two large completely automatic stations of somewhat conventional design have been placed into service. Except for refinements in equipment, the general design features have varied but little.

Since the Pleasant Hill pumping station represents the culmination of all the experience that the design and operation of automatic pumping stations in the Baltimore system have afforded, a description of it will indicate what we consider to be sound practice.

Details of structure

The arrangement of the structure is given in Fig. 2, and a general view of the equipment shown in Fig. 1. Access to the pump room, which is below ground, is had by means of an entrance kiosk and stairwell. Equipment placement and any heavy repair work is handled through a hatchway that opens through the ceiling of the pumproom to the ground surface.

Location of the pump room beneath ground was made with the idea of eliminating heating facilities, as well as for the purpose of reducing operating noise. While the apparent simplicity of this structure looks attractive from the cost angle, a closer study of conditions imposed by Nature on any underground vault, and the results of operating experience of a number of years show that the structure is not an economical one on the first cost basis. The paramount problem relates to drainage, both of groundwater and waste water from equipment. In Baltimore the use of any substitute for gravity drainage has never been considered and this has sometimes necessitated expensive drain lines to a point of discharge below the station sump, an element of cost that is properly chargeable against the building. Again, the possibility of the continual presence of groundwater on all sides of the structure demands that particular attention be paid to the waterproofing. This introduces another appreciable element of cost. These cost considerations are the principal elements adversely affecting the design. Against these, however, are balanced such items as the minimum exposure which the building presents, freedom from maintenance expense thus attained, the ability to select a station site to fit hydraulic conditions and free of objections to operating noises, and the elimination of heating facilities. Thus the design offers operating and maintenance cost advantages that overbalance higher construction costs.

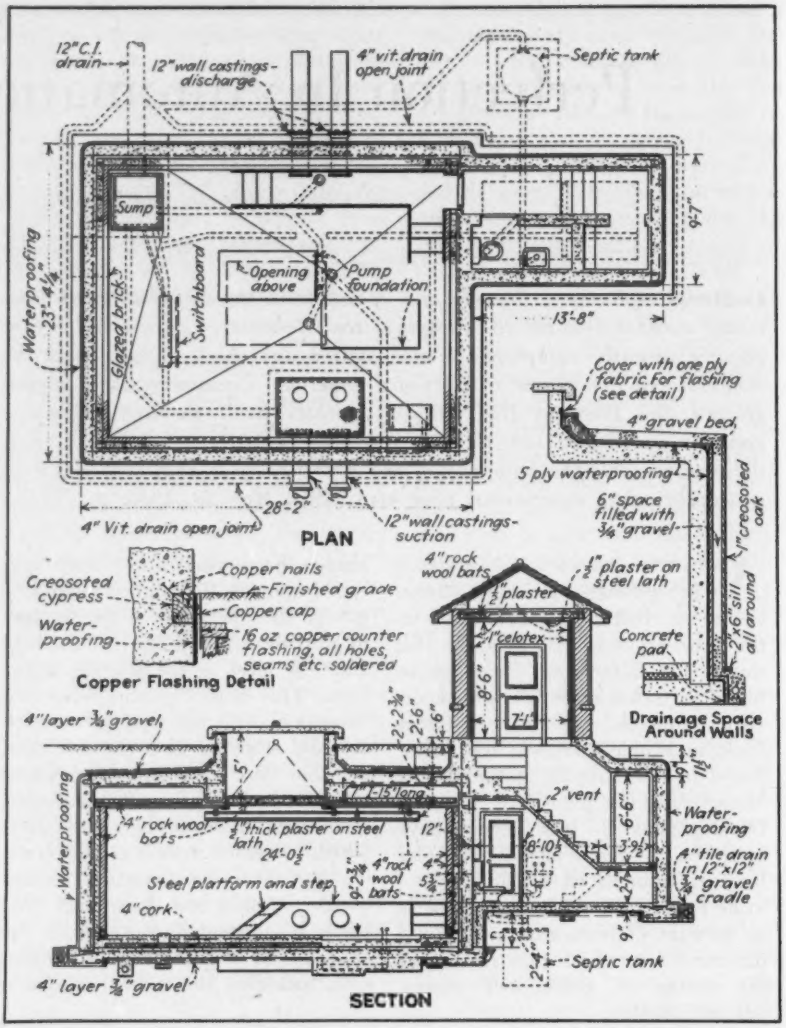


Fig. 2. Layout of the underground vault showing location of equipment and details of waterproofing.

Waterproofing methods

Waterproofing is most important. This is how it is done: All corners are rounded on a 6-in. radius and over the plane and rounded exterior surfaces of the structure, from the ground line to bottom of the foundation footings, there is applied a 5-ply built-up membrane waterproofing, the details of which are shown in Fig. 2. At the ground level the membrane is secured to a continuous creosoted cypress strip set in the concrete, the top edge of the membrane after application being protected by copper counter flashing fastened to the cypress strip before the latter is embedded in the concrete. The membrane is then completely encased in a protective jacket of creosoted lumber and a second similar construction, spaced 6 in. from the jacket in contact with the waterproofing and secured thereto by lumber spacers, is carried around the entire structure on the vertical sides from the surface of the top slab down to the building footings. Over the surface

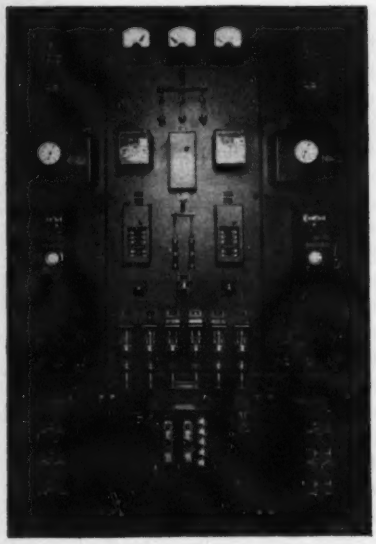


Fig. 3. The "brains" of the pumping station. Both control and supervisory devices are centralized on this switchboard.

of the top slab and in the space formed between the lumber jackets coarse gravel is placed to provide a pervious backfill in immediate contact with all portions of the building below the ground line; this is done so that groundwater cannot build up a head and thus possibly find a weak point for entrance. Water entering the gravel area is carried away by tile drain pipes embedded in the gravel.

Regardless of the effectiveness of this waterproofing method, moisture conditions in the underground stations that preceded the Pleasant Hill installation have at times been far from desirable. Atmospheric temperatures and humidity conditions at certain seasons produce moisture in profuse quantities on the floor and the lower part of the walls. It was at first thought that the waterproofing had failed but investigation showed that the water originated in condensation from chilled wall and floor surfaces.

The obvious first consideration in the design of the station, therefore, was a provision against such chilling. Accordingly, the walls, floor and ceiling of the pump room are completely insulated. And the floor which bears traffic is in effect a false one, the true floor slab being on a drained gravel bed. Cork block paving, 4 in. thick, has been placed between the two slabs. The finished walls of salt-glazed brick blocks, 4 in. wide on the laying face, are set out from the concrete structural walls by 6-in studding, and the brick is fastened to the studs by copper plate ties secured to the studs and laid in the mortar joints. The space between studs is filled by 4-in. rock wool bats, as is the space between the plaster ceiling and the concrete roof slab.

A false hatchway cover at the ceiling line, fully insulated, and a door of the refrigerator type account for all the access openings in the pump room. As there is little opportunity for the air in the pump room to change, the dehumidifying equipment that will be described later has had little work to do after the moisture from the fresh masonry and plaster work was removed. The operating life of this station, though brief, has spanned the seasons when the worst moisture condensation conditions are encountered in other similar stations, yet there is no evidence of moisture not normal to plant operation. So free of humidity is the room that the pumps and connecting pipes show no condensation.

Pumps and controls

To view the pumping equipment, entrance must be made through the kiosk, which is the only part of the station, except the flat cover over the machinery hatchway, that appears above ground.

The pump installation (Fig. 1) consists of two units, each composed of a 1,000-gpm single-stage centrifugal pump delivering against a net head of 127 ft. and driven at 1,765 rpm by a 40-hp squirrel-cage motor. These units are assembled opposite hand with respect to each other and are installed off center, an arrangement that reduces to the minimum the spacing requirements of the parallel suction and discharge piping and more closely groups the electrical and hydraulic controls connecting with the discharge valves. The discharge of each unit passes through a swing check valve and a hydraulically-operated gate valve. Operation of the latter is tied in electrically with the motor starter so that, when starting, the motor is fully up to speed before the discharge valve starts to open; and when the shut-down impulse is given, the discharge valve is almost fully closed before its final movement trips the motor by means of a limit switch actuated by the tail rod of the valve. Interruption of power or similar fault that would cause the motor to shut down during a pumping period would result in a hydraulic reversal that would be caught by the check valve. This arrangement is satisfactory for installations of the size being discussed, as the quantity of water pumped and the ramifications of the distribution system result in only moderate pressure rises in abnormal shutdown. This arrangement is not representative of Baltimore practice, however, in controlling pump discharges where large quantities are involved.

Another point of interest in the discharge control system is found in the four-way solenoid-operated pilot valves controlling the discharge valves. These are of a special design, evolved after numerous trials of commercially available equipment failed to produce a four-way valve that was reasonably free of maintenance. The principal feature of the pilot valve is the provision of soft seats with balanced areas, thus avoiding the need for the precise fit that the metal-to-metal seats in the usual type of pilot valve require, a fit that soon succumbs to wire-drawing with its inevitable results. A final feature in the discharge valve arrangement that merits attention is the provision of a small checked bypass around each valve, for the purpose of passing enough water to keep the pumps cool in the event the unit starts and the discharge valve fails to open. In the

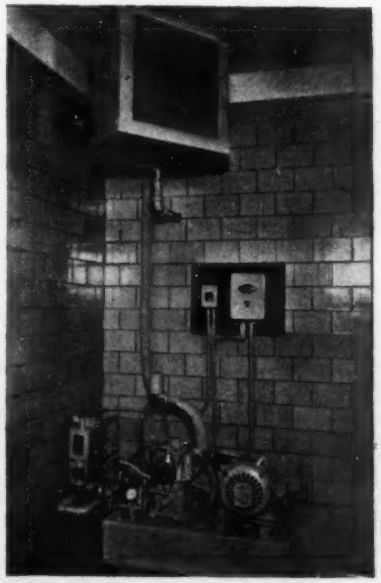


Fig. 4. Dehumidifying equipment consisting of a refrigerator unit and a ceiling-mounted condenser.

early days of automatic pumping in Baltimore, neglect of this precaution once caused a pump to overheat to the point where the paint on the pump casing blistered before the trouble was detected and corrected.

Switchboard and auxiliaries

All of the electrical controls in the station are centered in the switchboard and motor starter assembly shown in Fig. 1. Also seen in Fig. 1 are the venturi meter register for measuring and recording the station output, indicating and recording suction and discharge pressure gages, and a discharge pressure surge damping tank; the latter is an important item in a system of automatic pump control dependent upon pressure variations. Beneath the pressure gage panel is a battery of four pressure-operated switches, manifold from a pressure connection taken from the elevated tank that supplies the station suction, these serving to indicate over a telephone supervisory system the approximate height of water in this tank.

Details of the switchboard are shown in Fig. 3. The board consists of a central panel containing elements that control functions common to both pump units, and it is joined on the sides by individual control panels for each unit. The central panel includes indicating meters, with phase switches, for determining electrical values, phase failure voltage relays and accessories, main and control power switches, and instantaneous overload and lock-out and transfer relays. These last serve, as their name indicates, to transfer the load automatically from the selected to the reserve unit in case a fault develops.

Telephone supervision

The central panel also contains a selector switch for determining which of the units shall be the preferred one for a particular period, as well as an assembly of rotary switches and relays that is the plexus of the telephone supervisory system with which the station is equipped. By means of this system information concerning the electrical and hydraulic conditions existing at the station can be obtained at any time by a call made to the station from any point in the telephone system, the station equipment responding in a buzzer code with all the necessary information. All of the unattended automatic stations in the Baltimore water supply are equipped with this supervisory system. (See *Journal A.W.W.A.*, Oct., 1934).

The switchboard panels controlling the individual units are identical, each containing main and control power switches to permit a pump unit and its appurtenances to be isolated and worked on without disturbing the other unit, a thermal overload relay, a starting sequence relay, and a current balance phase relay. The latter is one of the most important protective devices where stations are fed by long overhead power lines that may suffer the loss of one phase during wind or sleet storms. Also mounted on each panel is a pressure governor, controlling the operation of the pump units through a drop in static pressure in the discharge main resulting from a lowered tank level and the build-up in operating pressure following closure of an altitude valve at the receiving elevated tank.

Special contact device

A feature of their construction which contributes greatly to the reliability of automatic pumping consists of a pair of small electro-magnets fixed to each of the "high" and "low" stationary contact points of the governor, the poles of these aligning with the sweep of a small armature attached to the pressure actuated pointer. Lacking this arrangement, it was our experience that the governor contacts, on closing, frequently caused the connected relays to flutter, with results that were far from satisfactory. With the added device described, however, closure of a governor contact causes the pilot current thus established to flow through the small electro-magnets and attract the armature on the pointer, firmly holding the contact closed until the relay controlled by the circuit thus made has definitely taken its proper position.

The motor starters placed at right angles to the switchboard assembly are three-step magnetically operated air-break devices, designed to bring the motors up to speed against a closed discharge valve without interrupting the power circuit once this is completed, and with a current inrush not in excess of 200 per cent of the full load current, such being the power company requirements.

The methods incorporated in the building construction to overcome the effects of condensation have been described, and in Fig. 4 is pictured the equipment that maintains the humidity in the pump room at such a low level that condensation does not happen. This consists of a small refrigerating unit controlled by a humidistat and serving to chill the exposed surfaces of the condenser that is mounted on the ceiling. A current of air is constantly circulated through the condenser by a motor-driven fan, the continuous operation of this fan being intended to prevent stratification of the air. If the humidity of the pump room air rises above the value established for its control, the chilling of the condenser that follows the starting of the refrigerator causes the excess moisture in the air to be condensed, this water being piped away to the drain.

Construction of the Pleasant Hill Pumping Station was financed with PWA aid by the Baltimore County Metropolitan District, of which Samuel A. Green is chief engineer. Plans and specifications for the improvement, which was the means of extending the Baltimore water system to developed areas that depended almost entirely on private wells, were prepared by the Bureau of Water Supply, which also cooperated with the Baltimore County Metropolitan District in supervising the execution of the contract work. Upon completion, the station was turned over to the Bureau of Water Supply for operation.

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Sludge Fertilizer Sales Reduce Operating Costs

The Milwaukee sewage disposal plant, through the sale of about 50,000 tons of sludge for fertilizer, finances approximately one-half of the yearly cost of operating the plant, reports the American Public Works Association.

Sold at prices ranging from $10 to $20 a ton, the sludge sales produced $767,387 during 1938. The gross cost of operating the sewage plant, excluding interest on bonds and sinking fund, was approximately $1,225,000 last year. The production and sale of the fertilizer on a commercial basis was started in August, 1926, about a year after the disposal plant was completed.

Buried Pipes Made To Talk Back

Contents in Brief—To warn excavator operators of the presence and precise location of buried pipes and cables, a new radio signalling device has been developed. Easily attached to any type of excavating machine, it permits rapid work in opening trenches in city streets with a minimum danger of damaging existing underground utilities.

A RADIO SIGNAL DEVICE for attachment to an excavating machine, which warns the operator of pipes and cables buried in the ground, has recently been perfected. Results obtained by The Public Service Gas and Electric Co. of New Jersey during the last three years indicate the usefulness of this device when digging trenches in city streets or in other places where underground utilities may be encountered. Known as the "pipe anticipator," it can be attached to any type of mechanical excavator. It operates from a 6-volt storage battery, and no wire leads are needed other than a suitable ground connection.

The mechanism was developed by Charles I. Maust, an engineer of the company, to meet the problem of making machine excavations without damaging existing underground utility structures. Previous experience had shown the unreliability of pipe line records and maps, and the impracticability of stethoscopes, supersensitive compasses, electrical induction and earth resistivity methods for this purpose.

Radio signal device

The automatic pipe anticipator finally evolved is a compact radio mechanism which can be easily attached to any standard excavating machine. Mounted in the operator's cab, it enables him to receive an audible signal by which he can distinguish whether his bucket teeth are touching an unknown pipe, or are one or more inches, a few feet, or many feet away from a pipe. Since the operator has full control of these distinguishing features he may dig rapidly and without hesitation.

Pipe anticipator devices have been built for and successfully used on the following machines: Ladder-type and wheel-type machines; clamshell, back-hoe and skimmer buckets; crawler, wheel-mounted and revolving cranes. They were also designed for use on the following: Tunneling, boring and pushing machines; dredging and mining machines; and marine salvaging operations.

Fig. 1. Equipped with a radio "pipe anticipator," this excavator operator is forewarned of buried pipes and cables crossing the trench.

Signals from the "anticipator" have functioned equally well when digging in sand, soil, shale, and rock; and it operates as well whether the material is wet or dry, or covered with pavement. Preciseness of automatically locating pipes and cables is not affected by their size, depth, or the material of which they are made, provided they are metallic.

The pipe anticipator was especially developed to permit mechanical excavation under adverse conditions. The radio signal mechanism forewarns the machine operator as his digging tool approaches buried metallic pipes and cables. The device has been used for visible signals, audible signals, and combinations thereof. The most practicable application employs the audible signal, however, thereby assisting the operator without diverting his eyes from his job or interfering with machine control. The signal emanates from a loud speaker which is mounted close to the machine operator's head; if desired, a headphone set can be substituted for the speaker.

How it works

The mechanism is adjusted to give a constant supervisory signal to indicate it is in workable condition. The strength of the signal distinguishes whether the working tool, such as the bucket teeth or auger, is either one or more inches from a hidden pipe, and it also distinguishes whether pipes are a few inches or a few feet apart. The operator generally adjusts his "soil" dial for obtaining a positive distinguishing signal when the bucket teeth are 6 to 12 in. from a pipe. The signal automatically increases in intensity of sound as the pipe is approached. A unique feature of the mechanism is its immunity to all electrical interferences.

The set, which includes an oscillator, special control equipment, amplifier, speaker and earphone, is contained in a box 11x8x5 in. deep. The control circuit includes the excavator bucket, the service pipe and the earth between the bucket teeth and the pipe. As the bucket moves into the earth toward a pipe, the impedance of the separating earth decreases, thereby increasing the volume of the signal in proportion to the inverse square of the impedance.

The mechanism is provided with "test", "soil", and "volume" control dials. The operator uses the test dial to simulate exactly the action of the digging tool any time he so desires. He adjusts the soil dial when

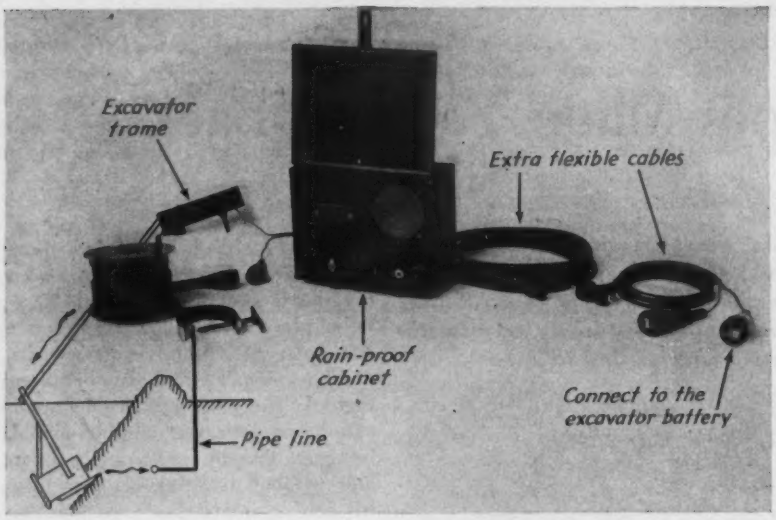


Fig. 2. The "pipe anticipator" and how it works. Wire connections are made from the cabinet to a 6-volt battery, to the frame of the crane, and to a nearby ground element, such as a fire hydrant. Radio impulses leave the teeth of the excavating bucket and when they impinge upon a hidden pipe or cable the loudspeaker in the cabinet gives forth an audible signal. The strength of the signal varies with the distance from the bucket teeth to the pipe.

the earth conditions change radically, such as during or after a storm or when the device is moved to a different section where the character of the soil may be different. Extremely rapid digging requires a "distant" setting of the soil dial, whereas relatively slow digging permits a "close" setting. The volume control is used to suit the operator's hearing.

Speeds up excavation

The excavation can proceed rapidly while the operator is getting a supervisory signal and is slowed down only after warning is given that the pipe is close at hand. Because of this, the machine can dig nearly all of the earth to be removed, leaving only a small portion under the pipe for later hand excavation.

Experience during the last three years while the mechanism was being tested and perfected has shown that excavator operators have no difficulty in learning to use the device. Furthermore, it speeds up the amount of work accomplished because the operator is assured that he will be forewarned when care must be exercised in digging.

The apparatus described has been patented by Charles I. Maust of the Public Service Gas and Electric Co., Newark, N. J.

Waterworks Construction Booms

In the first 5 months of 1939 more waterworks construction has been put under contract than in any 12-month period on record except the all-time-high year of 1938. This 5-month volume as reported by *Engineering News-Record* is $105,000,000 which compares with 1938's 5-month volume of $44,000,000 and the 1938 12-month record of $131,000,000. The latter is a 26 per cent gain over the previous high record of $104,000,000 for the 12 months of 1937.

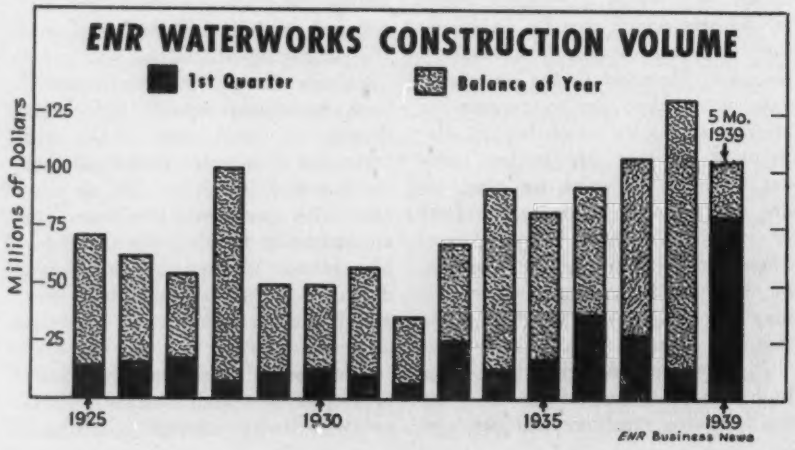
The first quarter of 1939 got underway fast with 4 of the 13 weeks exceptionally high due to awards of large contracts. This established a 520 per cent gain over the comparable period of 1938, an $80,000,000 volume compared with $18,000,000. The first large week in 1938 was in the second week of May. The 1939 gain for the 5-month period is 139 per cent over the same months of 1938.

Normal volume of waterworks construction without the big contracts ranges from $500,000 to $2,000,000 per week. Even if it averages $1,000,000 per week for the remaining 31 weeks of the year a new high record is assured without benefit of more big contracts.

But big awards scheduled for the second half of the year include New York's Delaware Aqueduct tunnels, $30,000,000; Toledo's $4,000,000 program; Los Angeles, $3,000,000; City of Decatur and DeKalb County, Ga., $2,000,000; Mount Vernon, Wash., $1,200,000; and the Springfield, Ohio, $1,100,000 program.

PWA allotments in 1938 for waterworks, reported on the construction trend page of this issue also set a high record of $115,770,000 and undoubtedly are largely responsible for the heavy volume of awards reported by *Engineering News-Record.*

While it is true that all types of public works construction registered gains during the first quarter (bridges, 134 per cent; sewerage, 92 per cent; public buildings, 60 per cent; streets and roads, 50 per cent), no activity has had such a dramatic impetus as waterworks.



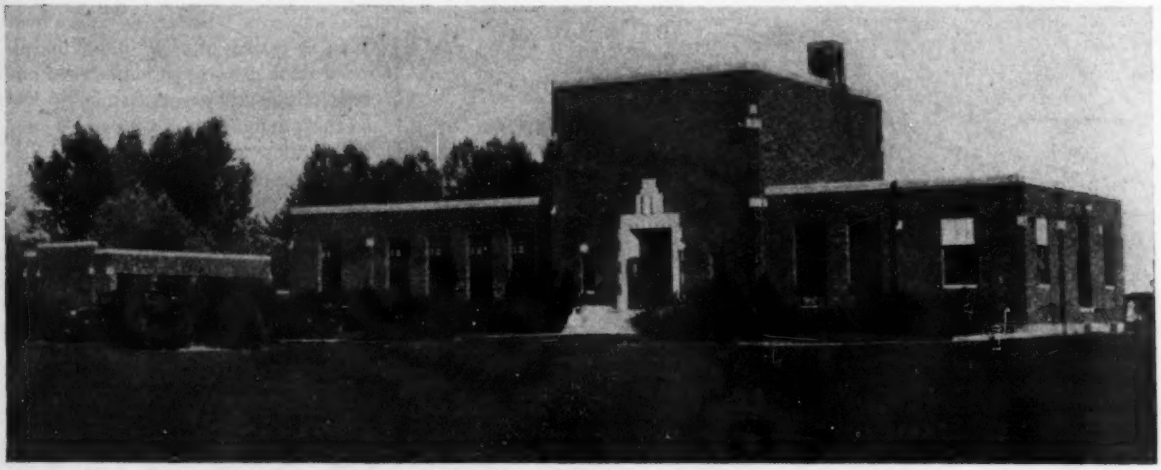


FIG. I. PURIFICATION PLANT FOR MOUNT CLEMENS, MICH., IS LOCATED IN AN ATTRACTIVE PARK SETTING.

To The Great Lakes for Water

PAUL HANSEN

Greeley & Hansen, Consulting Engineers, Chicago

Contents in Brief — Cities bordering on the Great Lakes recently have been abandoning unsuitable surface and ground supplies of limited capacity for the softer, abundant lake water. Plants in Toledo, Sandusky and Grand Rapids are under way and studies have been made in several other places. Mr. Hansen tells what has happened and why.

WITHIN THE RECENT PAST a number of projects have been initiated for obtaining water from the Great Lakes to replace existing supplies from other less satisfactory sources. Some of these other sources are surface streams, which furnish water that is hard, variable in quality, seriously polluted and generally difficult to handle in purification works. Others are from wells yielding water containing excessive hardness, iron, manganese and hydrogen sulphide. Moreover, wells often fail to yield an adequate supply and the static level of groundwater in many localities is receding at a rapid rate, so that excessive pumping lifts are required.

The principal projects for the substitution of Great Lakes water for other supplies during the last ten years are at Toledo and Sandusky, Ohio, Grand Rapids and Mt. Clemens, Mich. Other important cities, such as Saginaw, Chicago Heights, Muskegon Heights and Grand Haven, have studied the question of using the lakes instead of rivers and wells, but thus far have not come to definite conclusions. It is also pertinent to mention the experience of suburban towns adjoining the large cities of the Great Lakes. One by one many of these have abandoned existing well or surface supplies to obtain lake water from adjoining large cities.

The largest of the recent lake-supply project to get actually under way is that at Toledo (pop. 300,000). Hitherto, water was obtained from the Maumee River upstream from the city. As early as the 1870's this supply proved unsatisfactory in quality, and some of the earliest efforts in the United States at purifying water were undertaken here. The first modern filtration plant in Toledo was completed in 1910. It resulted in such an improvement in the water that the consumption increased beyond all expectation, and it became necessary to make additions the second year after completion and again in 1921. The existing filter plant has a nominal capacity of 56 mgd, which is scarcely sufficient to meet peak loads. Existing works have been able to serve the city until the present time, partly as a result of decreased consumption incident to the depression and partly due to the relatively wet years since 1927.

Maumee River water varies widely and rapidly in quality, depending upon the relative flow from several tributary streams, and therefore is difficult and costly to purify. The hardness varies from 138 ppm to more than 438 ppm with an average of 236 ppm. Oil-well wastes contribute oil and salt pollution. Tastes and odors due to organisms are at times strong. The possibility of using Lake Erie was first studied by Fuller and McClintock about 1925, and the waterworks officials have advocated a lake supply consistently since then. A study by Burns and McDonnell in 1935 indicated an economy in developing a Lake Erie supply as compared with increasing the capacity of the existing works and the addition of softening.

Late in 1938 the writer's firm was employed to prepare contract drawings and specifications for a $9,500,000 project as outlined by Burns and McDonnell. Subsequent studies of foundation conditions and other factors have resulted in some modifica-

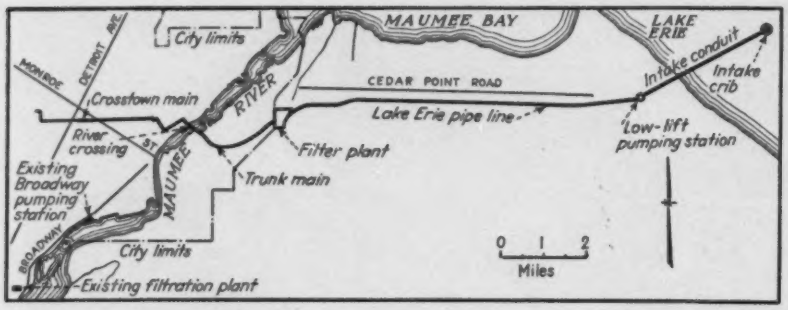


Fig. 2. Water for Toledo will come from Lake Erie following abandonment of the Maumee River supply.

tion of the general plan. The main features of the project (Fig. 2) are as follows: Intake and intake conduit, low-lift pumping station near the shore of Lake Erie, a 78-in. pipeline from the pumping station to the filter plant on the easterly edge of the city, filter plant, filtered-water reservoir, main pumping station delivering filtered water into the system and a trunk main extending from the pumping station across the city to connect to most of the existing trunk mains radiating from the old pumping station on Broadway. The existing pumping station will be held available for service and may be reconstructed to act as a booster station for meeting peak demands. The project is under construction, with contracts awarded for a portion of the trunk main and the lake pipeline.

Grand Rapids goes 30 miles

Grand Rapids (pop. 170,000) is the next largest city that is developing a lake supply. This is perhaps the most spectacular undertaking of its kind and is being carried out under the engineering direction of Consoer, Townsend and Quinlan. Water will be taken from Lake Michigan, 30 miles distant. Hitherto Grand Rapids has used the Grand River, the supply from which is softened by the lime-and-soda process. Subject to tastes and odors, the water is at times difficult to treat. Owing to the shallowness of the river at the intake the supply occasionally has been cut off by accumulations of ice. Since the first purification works were installed in 1912, the treatment plant has been doubled in size. The hardness of the Grand River water varies from 100 to 300 ppm and contains a substantial, but varying proportion of non-carbonate hardness. Lake Michigan water at the point of intake has an average hardness of about 125 ppm, practically all of which is in the carbonate form.

The general plan of this project, estimated to cost $4,100,000, is shown in Fig. 3. It will serve a population of 250,000 anticipated in 1965 and comprises as main features the following: an intake, a pumping station on the lake shore and a 46-in. pipe line 30 mi. long from the station to the existing purification works in the city. The design of the pipeline involves an economic balance between cost of the pipeline and cost of pumping under 300-ft. head. It is estimated that there will be sufficient saving in the cost of treating Grand River water to justify the lake supply investment.

Sandusky uses Lake Erie

Sandusky, Ohio, is another city that is abandoning its supply, now obtained from Sandusky Bay, and is developing a new supply from Lake Erie at a cost of $850,000. This development includes: submerged intake, a pipeline across Sandusky Bay to the purification works and pumping station on Big Island, a new purification plant and pumping station.

The first purification works were installed in 1909 and in 1931 these works were modified to permit softening. The water as taken from Sandusky Bay is polluted and during low water it was sometimes difficult to obtain a sufficient quantity because of the shallowness of the bay. Heavy ice formation also interfered seriously with obtaining a sufficient quantity in the winter. Sandusky Bay water is highly mineralized in contrast to the Lake Erie water which has a hardness at the intake of 100 ppm. While it is not anticipated that the latter will need softening, the treatment works are so designed that softening devices may be added later.

Other projects under way

North Chicago for many years obtained a highly mineralized water from deep wells in the Dresbach sandstone. Due to the draft on wells in this formation, many of which originally were flowing, the static level has been greatly depressed. Now it is necessary to lift the water from 300 ft. below the surface and the static level is still going down. In 1934 Allen and Vagtborg were employed to install a new lake supply

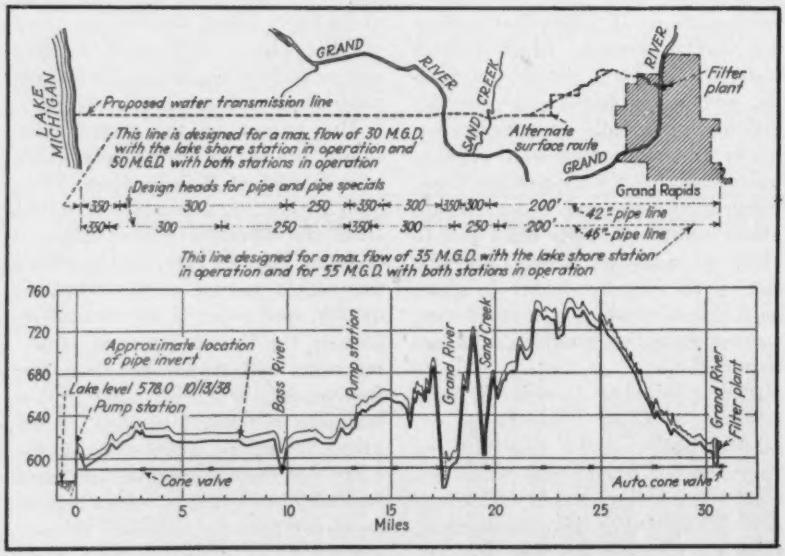

LAKE MICHIGAN
GRAND
RIVER
SAND CREEK
RIVER
Filter plant
Proposed water transmission line
This line is designed for a max. flow of 30 M.G.D. with the lake shore station in operation and 50 M.G.D. with both stations in operation
Alternate surface route
GRAND
Design heads for pipe and pipe specials
Grand Rapids
350 300 250 350 300 350 300 200'
42" pipe line
350 300 250 350 300 250 200'
46" pipe line
This line designed for a max. flow of 35 M.G.D. with the lake shore station in operation and for 55 M.G.D. with both stations in operation
760
720
680
640
600
Approximate location of pipe invert
Lake level 578.0 10/13/38
Pump station
Bass River
Pump station
Grand River
Sand Creek
Grand River Filter plant
Cone valve
Auto. cone valve
0 5 10 15 20 25 30
Miles

Fig. 3. Lake Michigan water will be brought to Grand Rapids through 30 miles of 46-in. conduit to an existing purification plant.

at a cost of $200,000. This included a submerged crib intake in Lake Michigan, a filtration plant, a water reservoir and high and low-lift pumping equipment, all combined in the same general structure.

In 1929 Mount Clemens abandoned its wells and completed a new supply taken from Lake St. Clair. There was no special economy in going to Lake St. Clair, but the well water, due to hardness and iron, was of poor quality. The new $600,000 supply is designed on the basis of 25,000 population anticipated in 1950; the present population is about 14,200. The project was carried out under the direction of Shoecraft, Drury and McNamee. The works have an attractive setting in a park near the lake shore, as shown in Fig. 1.

Muskegon Heights, a city adjoining Muskegon on its easterly side, is about to develop a supply from Lake Michigan. Hitherto it has obtained its water from wells in gravel formations. The lake project having an estimated cost of $300,000 includes: an intake, a pumping station, a 4.5-mi. pipeline, and a new filter plant and pumping station. Muskegon Heights has a population of 18,000 and the works have been designed to meet the requirements of double that number of people.

Grand Haven has a water supply obtained from wells penetrating alluvial deposits in the Grand River Valley. Occasionally these wells have been of uncertain yield containing appreciable quantities of iron. In 1925 a filter plant, installed at a cost of about $50,000, was intended to be used initially for removing iron from groundwater, but capable of purifying lake water should the city install a lake intake. To date the intake has not been installed as it has been found practicable to develop additional quantities of groundwater from new wells. However, it is generally recognized that sooner or later a lake intake must be installed.

Wells abandoned in suburbs

In the Chicago area nineteen suburbs with a combined population of 250,300 have abandoned well supplies in favor of taking water from Chicago. The number of these communities would probably be larger if the water supply were filtered. In the Milwaukee region four cities having a combined population of 54,000 have abandoned well supplies for Milwaukee water.

Toledo furnishes water to the major portion of Lucas County and parts of Wood County outside of Toledo and to the neighboring cities of Maumee and Rossford. Other neighboring towns are seeking to obtain water from Toledo now that a lake supply is being developed. Overtures from as far off as Bowling Green (15 mi. from city limits) have been received. In the Cleveland area numerous cities and towns, with a present population of 300,000 are utilizing Lake Erie as a source of water supply.

In Buffalo the situation is somewhat different. There the city supplies customers within the boundaries of Buffalo only. However, a company serves all of the suburban communities around Buffalo with water obtained from Lake Erie to the South of Buffalo. This filtered supply is distributed through long pipe lines, extending around Buffalo and terminating in and serving Kenwood, a suburb immediately adjoining Buffalo.

Permit System For Pavement Cuts

A systematic permit system for pavement cuts to be made in streets, alleys and sidewalks for installation of utility service lines or for other purposes, is recommended to cities following a study made by Public Administration Service. Through this control cities may avoid damage suits and minimize public inconvenience and expense, it was pointed out. Cincinnati is one of the few cities which have set up a detailed permit system for pavement opening, the study noted. Detroit utilizes high permit fees as a regulatory measure, while Philadelphia and Louisville are among cities which discourage cuts in new pavement by prohibiting them, except in an emergency, during the first five years.

In Cincinnati, any utility or private property owner wishing to make a pavement cut applies to the public works division of records for a permit. A deposit of cash or security to cover the approximate cost of pavement restoration, which is supervised by the city, must accompany the application. The application shows where and when the cut will be made, and its size and purpose. City engineers check the information to see that the cut or new underground structure will not interfere with the present or future location of gas, electric and other utility lines.

Copies of the permit are distributed to the division of records, the inspector, city auditor, crew foreman who will restore the cut, and the city waterworks department. The waterworks department collects for water used in construction. All revenues obtained from pavement cut permits go into a street restoration fund.

Cities should take every step possible to reduce the number of pavement cuts, the study said. One precaution is to require installation of all subsurface mains and conduits in newly opened territory before the streets are accepted as public property. If utility services are placed between the sidewalk and curb line pavement cuts will be unnecessary later.

Fewer Sewer Contracts Due to WPA Employment

In the recent progress report of the Committee on Sanitary Engineering, of the American Society of Civil Engineers, it is stated that it has become increasingly difficult to secure cost figures from contractors specializing in the construction of small distribution mains. Inquiry develops that in Chicago, where formerly there were dozens of sewer contractors, the city, although engaged in laying many miles of sewers annually, has not let a single sewer contract since 1931. All work has been under the WPA. Similar tendencies have been noticed in the East also.

The WPA has also exerted a minor influence on the type of waterworks building construction. At Lansing, Mich., a softening plant of 20-mgd capacity is being built wholly of reinforced concrete instead of the usual brick or stone superstructure. The principal reason was the desire to spend as large a proportion of the total for labor and as small a proportion for materials as practicable.

New Data on Main Sterilization

C. K. CALVERT

Chemical Engineer, Indianapolis Water Co., Indianapolis, Ind.

Contents in Brief — Sterilization of jute and hemp prior to use can be accomplished by treatment with cupric ammonium sulphate or by an organic mercurial compound, but bacterial multiplication starts again when germicidal action ceases. Newest substitute for hemp or jute is rubber compound made in tubular and solid wedge shape sections.

UNTIL a very few years ago little attention was paid to the condition of a newly-laid water main other than to remove visible dirt. The quality of the water delivered by a new main generally escaped notice because in many cities the distribution system is examined only infrequently. Furthermore, many new mains are dead-end extensions and are little used for some time after installation.

In some cities it has been the practice to place a dry chlorine-bearing compound such as chloride of lime in the line at frequent intervals at the time of laying. The amount used was calculated to produce a killing concentration in the water when the line was filled. Various periods of contact time were allowed before flushing the main of the chlorine bearing water. Some operators allowed the sterilizing solution to stand in the pipe only 30 min. while others kept it there overnight. From tests made a year ago it appears doubtful that this method of treatment resulted in a uniform distribution of chlorine throughout a line. When good distribution was obtained and if enough chloride of lime was used it is probable that significant bacteria introduced into the main during laying were killed. It is known now that such a line would not deliver water of the quality entering it because of hemp and jute contamination.

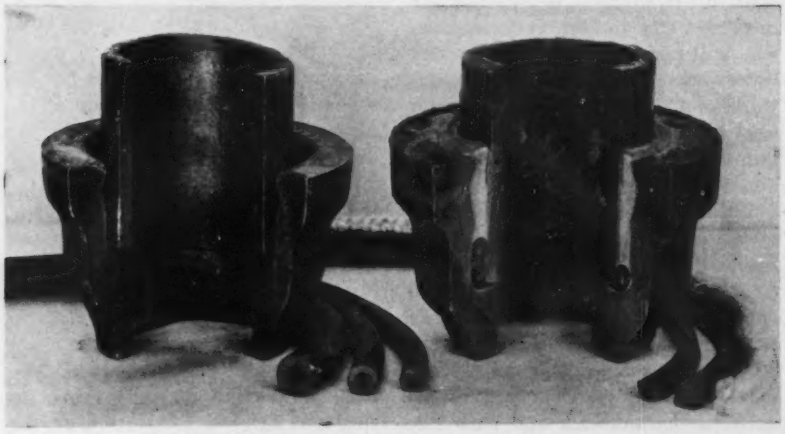
Several articles have been published which blame hemp and jute for poor bacteriological results, and Adams and Kingsbury (*Journal N.E.W.W.A.* March, 1937) reported exhaustively on the bacteria these materials contain. They found that even typhoid bacillus would grow rapidly in extractives from the dry fibres. It has been found subsequently that cotton yarn, as well as hemp and jute, is capable of feeding the natural bacteria in tap water.

Bacteria multiply in hemp

These observations show that heat sterilization, or treatment with chemicals, the effect of which is soon lost, will not produce the desired results because stray bacteria in the tap water will lodge in the packing and multiply rapidly, especially at summer temperatures. They show, too, why good samples are often collected from a line immediately after flushing out the chlorine, and why later samples will be found unsatisfactory.

The following is an example: A 12-in. line, 640 ft. long, was laid with no treatment of the pipe or hemp but care was used to keep out dirt. After laying it was flushed thoroughly. Chlorine was applied. At the end of 43 hr. the water with a chlorine residual of 90 ppm was removed. Twenty minutes after the last trace of chlorine was found, fifteen 10-milliliter portions were planted, none of which contained gas formers. The counts were five or under per milliliter. Twenty-one hours later the counts averaged nearly 500, and of twenty 1-ml. portions, eighteen contained coliform organisms. The line was sampled frequently for a period of 56 days. It showed some improvement toward the end but even then about 5 per cent of the 1-ml. portions contained coliforms and the counts were higher than normal.

Several treatments have been applied to hemp in an effort to sterilize it so that aftergrowth of the organisms naturally present in tap water will not be fostered. Chlorine in effective concentrations destroys the hemp fibre to such an extent as to render it useless. Copper sulphate crystallizes on the surface as drying progresses and is not left within the fibre. Cupric ammonium sulphate is much better and one line laid with hemp so treated gave the best results obtained. The natural carbonates in the water precipitate the copper as the hemp is wetted after being placed in the line and it remains effective as a mild germicide for a long time. Precipitating the copper



Rubber caulking material made in tubular and solid wedge-shaped sections, newest substitute for hemp or jute which has been under laboratory investigation.

in the hemp before placing it in the joint is only partially successful.

An organic mercurial compound, sold under the trade name of Klerol, was found to be effective in certain concentrations and under some conditions. The active ingredient is fixed within the hemp fibre and resists the solvent action of water for a long time, prolonging its effectiveness. Any concentration of it applied to the hemp before use improves the character of the water delivered by the line. Perfect results were obtained by its use in cold weather; but this was not the case in warm weather even when the pipe was swabbed with a solution of it just before laying. It is probable that other mercurial salts may fix themselves in hemp but the simple, obvious ones do not when used alone. Physiological salt solution aids in their penetration but is only slightly helpful in securing fixation which is very important in order to prolong the effect.

How hemp was tested

As pointed out by Adams and Kingsbury, bacterial multiplication reaches its maximum in about three days. The method of testing hemp samples in the laboratory was arranged to take advantage of this in order to magnify the results. Samples of hemp, either treated or raw, are weighed, placed in sterile glass-stoppered bottles and torn apart in tap water so that the fibres are exposed to the water. After standing for a half hour and following a thorough shaking, samples are withdrawn for examination. The bottle is then incubated at 20 deg. C. for three days, shaken again and sampled. The water is poured off, replaced with fresh tap water and incubated again. This operation is repeated as long as desired. Some samples have been treated in this way for more than 100 days in order to find the break-down point in an experimentally treated sample.

In a line laid with untreated hemp the food it contains is exhausted eventually and good water is delivered by the main. Lines laid in cold weather may deliver good water because the rate of bacterial multiplication is slow at low temperatures and by the time higher temperatures arrive the food material may be leached out. A similar result seems to be obtained in summer by the use of bactericidal agents in the hemp in which case growth is retarded until the soluble food material is all dissolved. In sampling new mains, especially in hot weather, it was found that samples taken from fire hydrants, even with the greatest care, are not reliable. The source of the contamination is not known. Good samples were obtained from a special sampling tap, sterilized before putting into place and protected from air contamination.

A great deal of experimental laboratory work has been done and a number of new lines have been sampled involving the examination of several hundred samples. The work has extended over a period of two years. It is felt that present practice is a long step in advance but that results are not entirely satisfactory even yet. Any hemp treatment yet tried involves considerable work. It must be cut into lengths, soaked in a solution of some chemical, dried, stored in sterile bags and handled carefully on the job.

Rubber packing available

A new caulking material to take the place of hemp has been introduced by Hayes R. Kuhns of The Leadite Co. It is under trial in some dozen water systems at this time. It consists of compounded rubber and it is made into two shapes. In one form it is simply heavy-walled rubber tubing of a diameter slightly larger than the width of the annular space between the spigot end of the pipe and the inside of the bell. The other form is solid and wedge shaped in section. When pressed into place it closes the opening just as the tube does.

Samples of the rubber tubing have been under laboratory test by the 3-day cycle method of 90 days and have caused no increase in total bacterial count of tap water nor contributed coliform organisms to it. It is believed that the effect on taste will not be important. While observations must be continued when summer temperatures and bacterial floras obtain, it is believed that the new packing will fill a long felt and important want. Its cost per joint is substantially the same as for hemp. The rubber should be treated with a germicidal agent before putting it in place and the pipe also treated, before and after laying, in some approved fashion.

From the epidemiological evidence the bacteria in water delivered by new mains may be said to be unimportant. A line laid with untreated hemp and then chlorinated heavily should be free from recent pollution even though coliform organisms and high total counts are contributed by the hemp. But the danger lies in the inability of the laboratory test to discriminate between the bacteria from hemp and from dangerous sources. If unusual results from the examination of water in a new line are attributed to hemp it might happen that important contamination would be disregarded. It appears possible now to lay mains in a fashion that will guarantee good results and it seems wrong to lay them in any but the best way known.

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Flood Protection For Louisville Water Works

Of construction work amounting to $508,730 by the Louisville (Ky.) Water Co. during 1938, the major part was in carrying out plans for preventing a repetition of the disastrous results of the 1937 flood in the Ohio River. The pumping plant is now protected against a flood crest 10 ft. higher than the present record of 57 ft. 10 in. Besides levee work, with riprap protection, alterations were made to the buildings by raising all window sills and installing steel flood-proof doors, while certain changes were made in the location of the machinery. The effects of the flood on the distribution system continue to be evidenced by the number of water main breaks and leaks.

Two sources of power that should be free from interruption are provided by a new overhead line and a new underground power cable. The flood-proof transmission line has wood poles about 200 ft. apart, well guyed both up and down stream, the poles being of such height that the conductors are well above a flood stage 10 ft. higher than the 1937 crest. The line connects with the new 13,800-volt belt transmission line of the Louisville Gas & Electric Co. supplied from that company's new Breckenridge substation, which is beyond the area of possible damage by river floods. The above particulars are given in the 1938 report of L. S. Vance, chief engineer and superintendent of the Louisville Water Co.

Pumps to Meet Peak Demands

D. D. GROSS

Chief Engineer, Board of Water Commissioners, Denver, Colo.

Contents in Brief *— Public opinion opposed to elevated tanks compelled engineers in Denver to meet peak demands for water with a reservoir and booster pump installation. The methods used in determining pressure and capacity requirements, and the manner in which an economical plan was evolved are described.*

OBJECTIONS against the erection of elevated tanks in the residence district of Montclair, a suburb of Denver, Colo., compelled engineers of the water board to seek other means of providing adequate supply and pressure during peak periods of consumption. Demands for the whole city were compared with those of the Montclair area and the size of the reservoir and pumps determined thereby. A reservoir filled during the night to supply a pumping station operated during the daytime solved the problem.

In 1933 Alvord, Burdick & Howson, consulting engineers, recommended two 2-mg elevated tanks to maintain pressure, and equalize the load on the pumping station supplying this area. Subsequent development of the transmountain supply bringing in water at a high level eliminated the necessity of most of the pumping stations, water coming into the high service areas from the new Moffat filter plant via a 7-mi. steel conduit 63 and 57 in. in diameter. This supply supplants in large measure that formerly obtained from the South Platte River and delivered by gravity to the main portions of the city. Storage reservoirs on either side of the city floated on the distribution system and supplied the necessary water for adacent pumping stations in turn supplying the higher areas; the largest district thus supplied is the Capitol Hill high service area, of which the Montclair District under discussion, forms part.

To obtain information as to pressure conditions in the Montclair section, recording pressure gages were attached to a number of hydrants in the district. These recording devices were provided with a lock-box housing shown in Fig. 1.

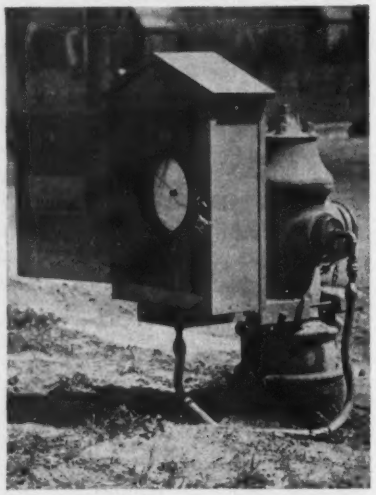

Fig. 1. Portable recording pressure gage assembly used in tests.

Analyzing the records

The Montclair area is supplied from the Capitol Hill District by a 3-mi. supply pipe 30 in. in diameter. The most important records were those obtained from the pressure gage connected to a hydrant on this conduit where the elevation is 167 ft. These charts indicated the pressures on the main supply, which comes into the district at this point, and show the maximum head at about 80 lb. This pressure was found to give good service throughout the district, and the service remains good until the fall in pressure, due to use of water, is down to 70 lb. Below 70 lb., unsatisfactory service occurs. Pressure records obtained at this location for 30 days, studied in conjunction with records of the total consumption of water throughout the entire city, revealed that at the 70-lb. satisfactory pressure the total consumption in the entire city is 70 mgd. The average daily demand is 57 mgd. It was apparent that the service throughout the Montclair District was satisfactory under average conditions and to a point at which somewhat more water is being used than under average conditions; and that it is necessary to make provision for additional water only on days of unusually high consumption, and then only during the time of peak consumption.

Records indicate that the total number of services in the Capitol Hill District is 15,000, and the population in the Montclair District to be provided for, including the Fitzsimons General Hospital and the Army Air School at Lowry Field, is 10,000. The consumption in the Capitol Hill District is 21 per cent of the total consumption of the city and the consumption in the Montclair District

TABLE I — ESTIMATED OPERATING EXPENSES AND COST COMPARISON

Mil. gal. pumped per year 100 to 200, average of	150
Cost of salaries and wages, average season of 5 months	$1,500
Other expenses	200
Power at $13 per mg pumped	1,950
Total Operating Cost (without interest and depreciation)	$3,650

(Assuming that 150 mg per average year is required, compared with the cost of supplying the same amount of water through elevated storage tanks)

	Tank Installation	Montclair Station
Capital invested	$270,000	$125,452
Depreciation	5,400	2,420
Interest on investment at 3 per cent	8,100	3,763
Operation	None allowed	3,650
Total annual cost	$13,500	$9,833

is 3 per cent of the total requirements of the city.

Peak loads in Denver reach a higher maximum than in most cities, because of irrigation and lawn sprinkling uses. Hourly records indicated that on a peak day the pumping loads varied from a minimum rate of 10.5 mgd to a maximum of 107.5 mgd with a total rate for the day of 44.18 mgd. (Fig. 2). The peak hourly rate in round numbers was 2½ times the average rate during 24 hr. of the maximum day of the year, this high ratio of 2½ being the relation of maximum rate of pumpage to total pumpage on a peak day applied when irrigation restrictions were in force. Lawn and garden sprinkling was permitted from 6 to 9 a.m., and from 5 to 8 p.m. on alternate days of the week, but all users were permitted to irrigate on Sunday, thus giving every user permission to irrigate four days a week. The increased use of water during these hours placed a heavy load on the water plant, the rate of use of water rising rapidly to a maximum from a point below average.

In 1937, irrigation regulations were changed and irrigation is now permitted at any time during the day provided water is not run to waste. This rule has had the effect of flattening the curve and the ratio of maximum use to total use has fallen from 2½ to 2. This change simplifies operation and improves pressure (Fig. 2). The effect on the amount of consumption on peak days is interesting. In 1930, under restrictions as stated above, the per capita consumption on the maximum day was 353 gal. In 1938, with all-day irrigation, the per capita consumption on the maximum day was 394 gal. The year 1930 was used as it is characteristic, and careful records were worked up that year in connection with the construction of a new pumping station. Since 1930 there has been a gradual, although not uniform, reduction in the average per capita consumption per annum. The daily average per capita consumption in 1930 was 208 gal. and in 1938 it was 160 gal. This reduction is probably due to several reasons, a difference in precipitation accounting for part.

Since present facilities provide for the average consumption in the Montclair District, concern for an additional supply of water begins when consumption in the entire city reaches 75 mgd. Estimates were made of the amount of water and the pressure required, using the information on the records enumerated above and the statements as to peak loads. When the total city consumption is 75 mgd the consumption to be provided for in the Montclair area is estimated to be at the rate of 2.25 mgd, with an hourly peak rate of 4.5 mgd. When the maximum consumption of 130 mgd is reached in the city the total on a maximum day in the Montclair area is estimated to be 3.94 mgd and the peak hourly consumption rate 7.8 mgd. The problem then was to provide for this maximum demand and to do so without the use of elevated storage tanks.

Between the two proposed sites for elevated tanks is a depression or natural reservoir site capable of accommodating upward of 20 mg storage, with a minimum amount of excavation. This site was acquired by the Board of Water Commissioners and construction is now under way for the installation of a 5-mg reinforced concrete box-type reservoir. A small pumping station is being built adjacent to this reservoir. It is equipped with one 5-mgd and one 10-mgd pumping unit. The first cost of the reservoir and pumps is much less than that of elevated storage but the operating cost is higher.

The elevations of the proposed tank sites are 220 ft., the towers were to be 100 ft. high and the tanks 25 ft. high, giving a high water elevation of 345 ft. The high-water elevation at the Capitol Hill station was 360 ft. Regulating valves at this station have now been adjusted to give a high-water elevation at that point of 375 ft. The elevation of high water in the Montclair Reservoir will be 210 ft. and the discharge pressure on the pumps which are set below the reservoir will be 70 lb. The high-water elevation on the discharge will be about 355 ft.

It is estimated that the Montclair station will be in service five months in the year, but that it will only be

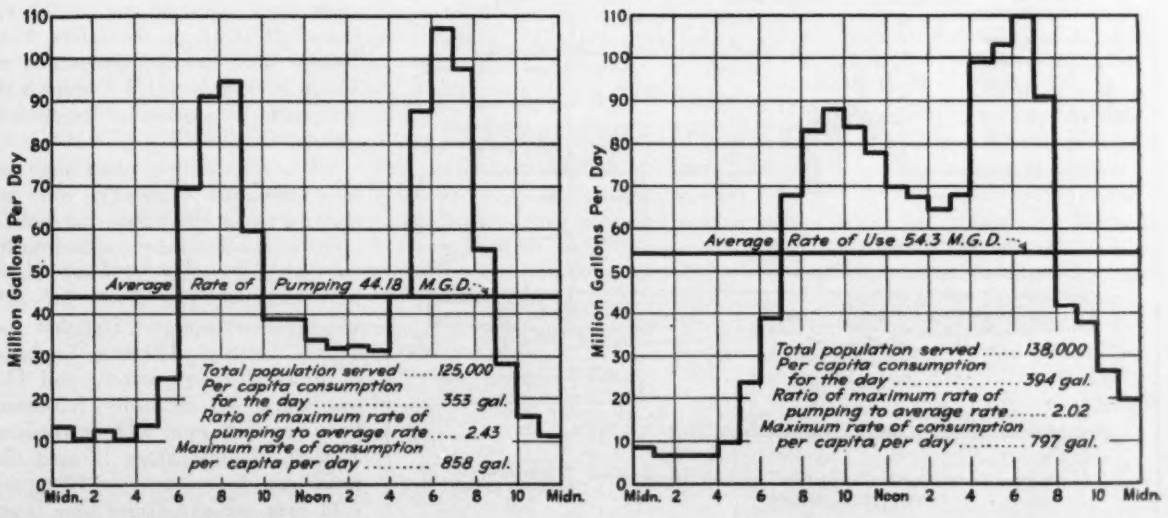
Million Gallons Per Day
Average Rate of Pumping 44.18 M.G.D.
Total population served 125,000
Per capita consumption for the day ..... 353 gal.
Ratio of maximum rate of pumping to average rate 2.43
Maximum rate of consumption per capita per day ..... 858 gal.
Midn. 2 4 6 8 10 Noon 2 4 6 8 10 Midn.
Million Gallons Per Day
Average Rate of Use 54.3 M.G.D.
Total population served 138,000
Per capita consumption for the day ..... 394 gal.
Ratio of maximum rate of pumping to average rate 2.02
Maximum rate of consumption per capita per day ..... 797 gal.
Midn. 2 4 6 8 10 Noon 2 4 6 8 10 Midn.

Fig. 2. Typical maximum day consumption in high level districts in 1930 compared with peak hour demand (left) when irrigation was restricted. (Right) Relation between peak hourly consumption and total demand on same area in 1938 with irrigation restrictions lifted.

necessary to start the pump on from 75 to 115 days in a season; the time of pumping on these days will vary from 2 to 11 hr. During the remainder of the day the gravity supply will meet the demand of the district. At night it will be possible without seriously impairing the pressure in the district to fill the Montclair reservoir with water to supply the pumping station the coming day. The amount of water actually pumped per day is estimated to vary from 375,000 to 3,850,000 gal., and the total pumpage per season from 100 to 200 mg.

The comparison shown in Table I is made on the basis of the ability of this type of construction supplying the peak demand on a maximum day. Furthermore, while this comparison is made on the basis of an ultimate capacity of 4 mg, the reservoir-pumping station combination has a 5-mg capacity.

Soft Water for St. Paul

LEONARD N. THOMPSON

Engineer and General Superintendent, Water Department, St. Paul, Minn.

Contents in Brief—Additions to the 19-year old filter plant at St. Paul, Minn., include provisions for softening. The design involved fitting new units into the existing hydraulic gradient without interrupting service. Clarifiers are covered with unsupported dome roofs which have a diameter of 150 ft.

ENLARGEMENT of the 25-mgd water purification plant serving St. Paul, Minn., includes facilities for softening by the lime-soda ash method as well as the addition of six 3½-mgd filter units to the existing twelve filters of similar capacity. The designs had to conform to the existing head losses and hydraulic gradient through the old plant as well as provide for continuous operation with a maximum shutdown of not to exceed 20 hours. These requirements influenced the construction schedule. Use of dome roofs over the clarifiers also introduced some novel construction methods.

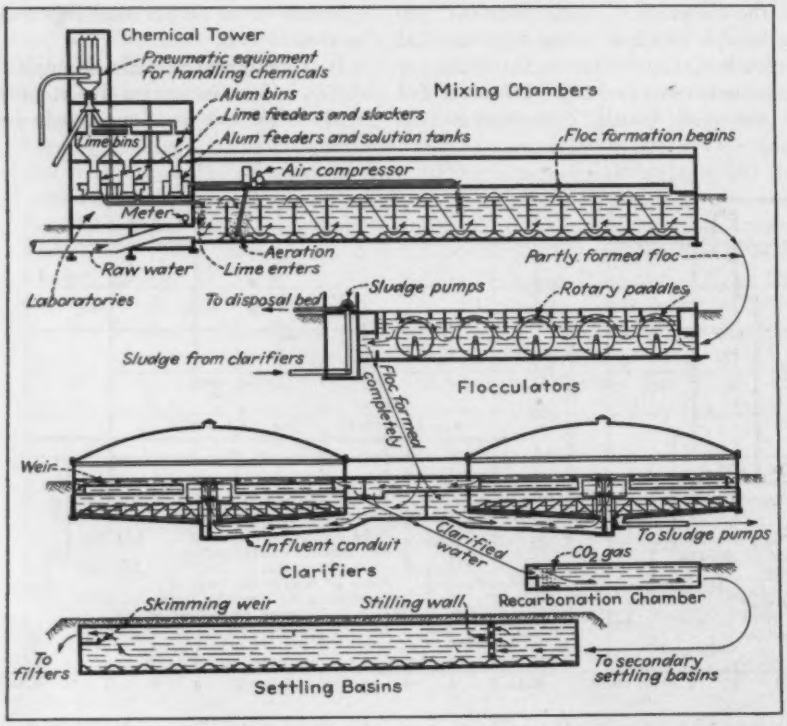

Fig. 1. Softening treatment preliminary to filtration. The lime-soda ash method is employed and the water is conditioned in a mixing chamber and a flocculator.

Ninety per cent of the water supply of the city is taken 20 mi. upstream from the Mississippi River and is pumped through 8 miles of 60-in. concrete conduit into a chain of lakes. From the last of these lakes it flows by gravity through a 90-in. conduit to the 42-mgd rapid filter plant put into service in 1921. While the average consumption is 25 mgd in the summer months, the demand reaches 40 mgd, with maximum days of 60 mgd, which boosts the filter rates to 175 mgd per acre, the maximum for the coagulation and mixing units. The total storage of 65 mg (one day's supply) was considered too small a margin for safety. Low interest rates and the opportunity to obtain a 45 per cent PWA grant both indicated the wisdom of immediate extension.

When the existing plant was put into operation softening was attempted for a short time but public opinion was decidedly opposed to it. In the intervening 18 years views have changed. The desire for soft water comes from the fact that the supply contains 172 ppm hardness of which 23 is permanent and 149 temporary or alkalinity hardness. Calcium is 40 ppm and magnesium 17 ppm. If lime alone is used the water can be softened to 100 ppm; with soda ash and excess lime treatment the hardness can be reduced to 60 or 70 ppm. A softer water will induce industries to change over from

an artesian well supply now used to the extent of 17 mgd.

Existing structures consist of two baffled mixing chambers, two settling basins, twelve filters, alum storage bins and a 16-mg filtered water basin which acts as a low-service reservoir and wash-water reservoir. The additions are a flocculator, two circular clarifiers, a recarbonation chamber, six filters, lime storage, chemical feed machines and pneumatic equipment for handling chemicals.

In the redesigned plant the two mixing chambers (14.5x220x20 ft. deep) will be operated in parallel instead of in series as now. To conserve head, part of the existing under-and-over baffles will be removed and spaced farther apart than the present 10 ft. Alum and lime will be introduced at the entrance of the raw water into the mixers, passing thence to the 80x160-ft. flocculator building containing five units set with paddles at right angles to the flow. The two 150-ft. clarifiers are 24 ft. deep at the center and are provided with circumferential steel weir plates and sludge scrapers. Sludge will be pumped 2,000 ft. to an old lake bottom of 20 acres and lagooned. The water passes to the recarbonation chambers (160x20x20 ft. deep), thence to the existing coagulation basins which will be used as secondary settling basins. The water skimmed off the top of these basins will pass through raw water conduits to the eighteen filters.

The main filter collectors from the 3-in. laterals are 28x36-in. rectangular concrete boxes or conduits which serve as structural members. The laterals have $\frac{7}{16}$-in. holes on the lower quarter and are connected to the collectors by 42 3x3x4.5-in. cast-iron tees cast into the filter box floor on 18-in. centers. Precast concrete perforated blocks are laid over the filter bottoms and between the laterals. Over these are placed 23 in. of gravel and 25 in. of sand. The steel washwater gutters have planed edges. A washing rate up to 33 in. vertical rise is provided. All valves are hydraulically operated.

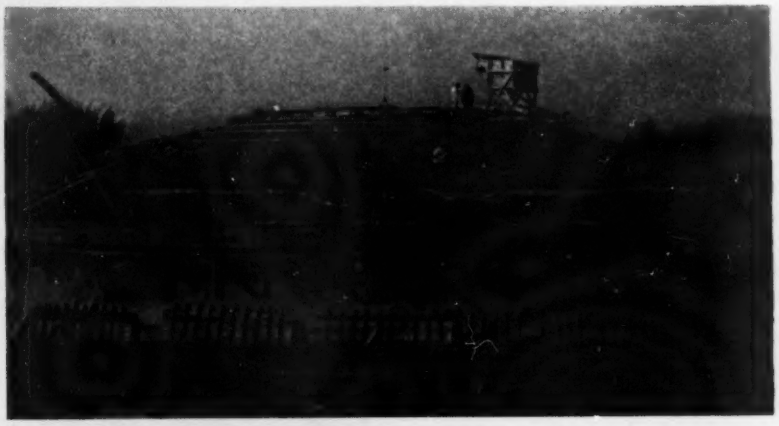

Fig. 2. Concrete was deposited on the clarifier dome in 5-ft. concentric rings in a 12-hour continuous operation.

A new brick and steel room 32x35 ft. provides for several months' storage of lime, and a 4-story chemical headhouse contains all new mechanical machinery for pneumatic equipment, gas scrubbers and driers, compressors, lime slakers and alum solution equipment. Both manual and automatic control are provided for the chemical feeds.

The unsupported dome roofs on the clarifier buildings, 150 ft. in diameter, are said to be the largest of this type ever built. A low unit of compressive stress under dead load of 150 lb. per sq. in. is claimed for these domes. A negligible amount of steel reinforcing is included in the 5-in. roofs which are prevented from spreading by 21 1½-in. steel bands in a concrete ring around the periphery of the tank at the base of the roof.

Concrete for all walls was handled by crane direct to the wall forms or by buggies. Concrete was placed in the domes with two cranes working back to back. Each crane worked over a half circle, going around the dome in concentric circles 5 ft. wide. Each roof was placed in 12 hr. starting at 4 a.m.

The greatest difficulty in building the domes was in forming. Shores reached a maximum height of 54 ft. and it was necessary to cut the joists both round and beveled. Since the two structures are duplicates it was decided to re-use shoring and forms in the second structure after the first had been completed.

Ready-mixed concrete was used throughout the contract. All concrete to be below water level was of high cement content, 6¼ sacks to a yard. That above water contained one sack less. Narrow walls and heavy reinforcing made ordinary spading or puddling impracticable, hence long mechanical vibrators up to 1¼ in. in size and some with hoses 28 ft. long were used.

The first of the seven contracts which totaled $650,000 was let in 1937. With 85 per cent completion on May 1, the entire plant is scheduled for operation in August. PWA contributed $270,000. The Okes Construction Co. has the general contract, D. W. Hickey Co., mechanical valves and piping and Walter W. Magee Co., excavation and concrete footings. All are from St. Paul.

The design and construction has been under the direction of the writer with plans worked out by department engineers. Ellms & Levi, Cleveland, Ohio, were consulting engineers on design. On construction George A. Roden is resident engineer, Al. Schroeder assistant resident engineer, and I. V. Jones, PWA engineer. William A. Parranto is president of the Board of Water Commissioners. G. M. Shepard, city engineer.

TABLE I — FLOW RATES AND DETENTION PERIODS IN PLANT UNITS.

	Velocities Ft. per Min.			Retention Period In Min.		
	Rates of Flow mgd			Rates of Flow mgd		
	40	60	70	40	60	70
Mixing chambers 950,000 gal. cap.	6.3	9.6	11.	35	23	20
Flocculation basin 1,385,000 gal. cap.	3.05	4.57	5.34	48	32	27
Clarifiers (operated in parallel) 4,770,000 gal. cap.	0.8	1.2	1.4	172	115	98
Recarbonation chamber 420,000 gal. cap.	10.0	14 0	15.6	15	10	9
Secondary settling basins 6,700,000 gal. cap.	0.9	1.4	1 6	240	361	137

Pump Troubles and Cures

K. B. HUMPHREY
Sayreville, N. J.

WHENEVER pumps are not operating at capacity, or difficulty arises in starting, look to the suction side of the pump. This is particularly true of the centrifugal pump which is widely used on construction work. Because of the temporary location of pumps on work of this kind, the connections are rigged in the quickest and easiest way, and usually a hose is used instead of pipe for the suction. For best operating results the following points should be given attention.

The suction line must be airtight, not just watertight.

Bends should be avoided, and no part of the suction line should be higher than the inlet of the pump.

The shorter the suction line, the less likelihood of trouble.

The suction inlet should be well below the surface of the water to be pumped. Eddies or whirlpools near the suction usually indicate that there is not enough submergence.

The section line should be supported so that no strain is taken by the pump itself. A short length of straight pipe between the hose and the pump inlet will improve operation.

Many pump troubles can be traced to poor suction.

A small air leak in the suction line will cause loss of capacity. Some of the self-priming centrifugal pumps will handle a very large quantity of air without stopping completely, but it must be remembered that air in the suction line is under reduced pressure and consequently has a greater volume than air under atmospheric conditions. This is why even a small leak may cause a disproportionate loss in capacity.

When a pump is located above the source of supply, atmospheric pressure forces the water up into the pump. This pressure has a theoretical lift of about 34 ft. at sea level. It is good practice, however, to limit the actual lift at least 6 ft. below the theoretical. The closer the pump to the suction supply, the less pressure required to force the water up. In other words, less vacuum is required. And under reduced pressure any tendency to leak air would be lessened.

Atmospheric pressure must not only force the water up to the pump but it must also take care of any loss in head from friction. Since bends, fittings, foot valves, etc. create high friction losses they affect the total possible lift. Therefore it is good policy to keep the suction line as straight and as short as possible. No part of the suction line should be above the inlet of the pump, because a pocket is formed which may trap air and thus reduce the area of the suction intake. This increases friction losses and if the air happens to come through as a slug it may cause pump stoppage.

Water Treatment Plant In Florida Laboratory

A HYDRAULIC LABORATORY said to be the finest in the East was recently placed in operation at the University of Florida, Gainesville. Housed in a three-story reinforced-concrete building, the laboratory has been designed for demonstration purposes as well as research on problems concerned primarily with low-head flows. The maximum head available is 50 ft. Facilities have also been provided for studies on oil flow.

One of the features of the laboratory is a complete 60,000 gal. per day water treatment plant. The units, all of which are built of reinforced concrete, comprise a flash mixer, flocculation tank, sedimentation tank and a rapid sand filter. The latter is 4x5 ft. square. Another feature is the manner in which every piece of equipment has been referenced to a common datum plane and marked with its particular elevation. Thus it is possible to determine quickly the difference in elevation head between various pieces of equipment.

There are eight centrifugal pumps in the laboratory, ranging in capacity from 100 to 5,000 g.p.m. The flow system is a closed one, and the channels and piping are so arranged that the water will be re-used over and over again. Make-up water will be obtained from the overflow of the university swimming pool. Steel tanks to furnish an elevated head supply to individual pieces of apparatus are located on a balcony. These tanks are arranged so that they can be overflowed continuously to provide a constant head.

The hydraulic laboratory is the first project completed in a major building program under way. It was designed by Thomas M. Lowe, associate professor of civil engineering at the university, and Blake R. Van Leer, former dean of engineering and now dean of North Carolina State. The building was constructed and financed by WPA, at a cost of about $65,000.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Prod Locates Pipe Lines

W. S. FOSTER
Inspector, Iowa Highway Comm., Ames, Ia.

Often in road construction it is necessary to trace down tile lines. A prod, such as the one illustrated, helps materially to locate these lines. This particular prod, 6 ft. long, is made of ½-in. steel with a 1-in. welded pipe handle. Of particular importance is the shank of the point, slightly larger than the shaft itself. This makes the hole slightly larger and prevents the shaft from binding in the ground. In soft ground, one man can handle the prod, but under average working conditions, two men can handle it more effectively. This particular prod was developed by W. B. Spangler, resident engineer for the Iowa Highway Commission, and his field force.

Prod for locating buried tile drains.

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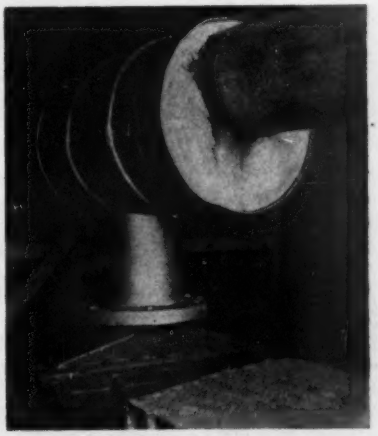
Oil Drum Pipe Elbow

An old 50-gal. steel oil drum serves as a reducing elbow and connection between ventilating blower and vent pipe on the Olmsted and Alpine-Draper tunnels, Provo reclamation project, Utah. As shown in the illustration, the rigid nipple from the blower is cut and welded into the side of the drum, while the larger sheetmetal vent pipe leading to the tunnel is fastened to the end of the barrel. The ventilating system is operated both pressure and exhaust, and the drum connections stand up under either method. Paul Guinn, superintendent, and C. E. Hauenstein, master mechanic, for Thompson-Markham Construction Co., contractor on the two tunnels, devised the barrel elbow.



Oil drum elbow for tunnel ventilating pipe.

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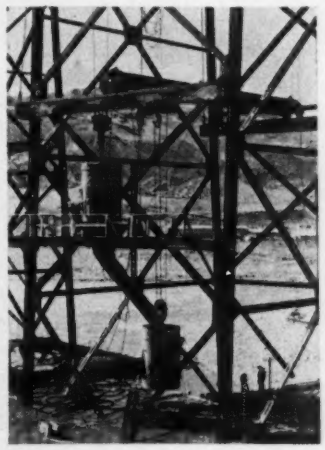
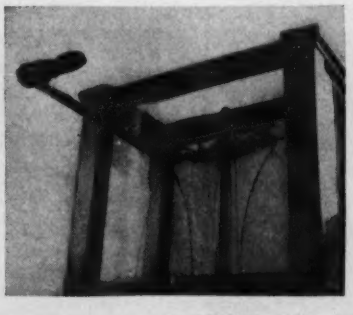
Tractor Rolls Pipe

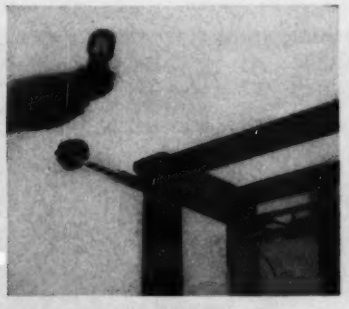
Cast concrete pipe are stocked for curing and storage in the molding yard of the Lock-Joint Pipe Co. at Rock Island, Ill., by rolling them to place by tractors. As shown by the accompanying illustration the tractors are fitted with two pusher wheels which bear against the rolling pipe.



COULEE CONCRETE

At Grand Coulee Dam the buckets slung over the side of the trestle from any of the cranes on top of the trestle discharge into a hopper whose chute leads into the under-trestle bay being poured. The second bucket is handled by an auxiliary overhead crane on girders temporarily attached to the trestle bents at the desired height.





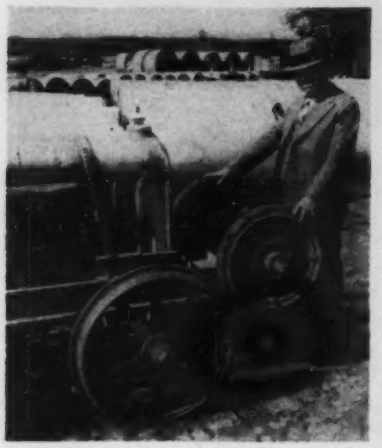
SPOTLIGHT FOR LABORATORY BALANCE

To insure accurate readings and facilitate operation of a precision balance of the type used in water and sewage plant laboratories, good light is essential. At the New Jersey Sewage Experiment Station in New Brunswick, all the balances were recently equipped with spotlights installed at a cost of 15c. each. The material obtained in a 5-and-10-cent store, consists of an electrical socket and a combination plug light with switch. The socket is attached to a metal rod fastened to the balance cabinet as shown. This arrangement was developed by Clarence Henderson, research assistant.

OLD-TIME METHOD AIDS TRENCH WORK

Stepping lively to sheet a trench in quicksand, these WPA workers at Jacksonville, Fla., are finding an old-fashioned method is the best and cheapest technique. After the trench is partly opened, wales are placed and the 2x10-in. wood plank sheeting is set up. Then the "driving gang" put their cleated runway on top of a plank and as they walk up, a water jet is applied to the base of the sheeting. The sheeting is forced down into place rapidly and with ease.

The tractor shown is a small one but a large machine of the crawler type is similarly equipped. The pipe being handled ranges from 24 in. to 108



Tractor with pusher wheels for rolling cast concrete pipe.

in. in diameter. A similar arrangement could be used for pipe of other materials than concrete.

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Water Sampling Simplified

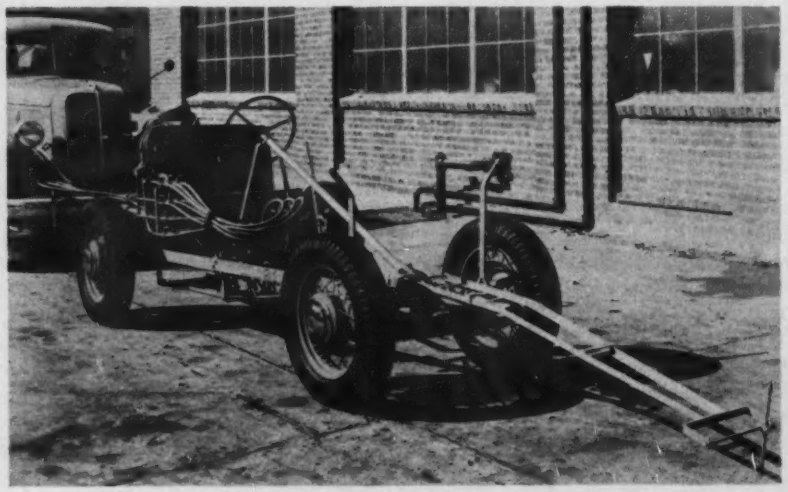
To facilitate the collection of samples in water mains that are separately chlorinated, this multi-faucet basin is used by the Baltimore Bureau of Water Supply. The two upper faucets are hot and cold water services to the slop sink. But the lower faucets each connect to separate mains leaving Druid Lake Reservoir, the water in these mains flowing at different rates according to the demand, and being individually chlorinated according to the flow. The pipes connected with these faucets are tapped into their individual mains at a point considerably downstream from the place where chlorine is added, thus permitting a thorough distribution of the chlorine in the water before the sampling point is reached.

Sink with faucets from separate water mains.

• • •

A Three-Line Striping Rig

A device for marking traffic lines on highways, developed by the California Division of Highways, makes stripes in which three colors, similar or different, may be applied simultaneously. The rig is mounted on a four-wheel chassis to be pushed ahead of a small truck. The truck carries power-operated compressor, agitator and three pressure tanks of about 65 gal. each, with rubber tubes leading to the striping unit. The pressures used in the spray guns are about 30 to 40 lb. per sq.in. The unit itself is less than 10 ft. long and has a folding pointer which is extended out in front, when the rig is in operation, to keep the stripe on exact alignment. There are three interchangeable spray guns with controls convenient to the operator's seat. The interchangeable feature is needed because the yellow line usually has to be changed to opposite sides of the center stripe on opposite ends of each vertical curve.



A device for making three traffic stripes simultaneously.

WHY TAKE THE OLD ROAD?

LAY-SET Preformed is as much improved, for many applications (over the wire ropes of 1926), as the smooth stretch of concrete is better than the mud-ruts of yesteryear. With LAY-SET Preformed available, the use of non-preformed wire rope on your machine is like purposely choosing a bumpy, slow-moving detour when driving. LAY-SET Preformed wire rope assures your machine smooth, less-interrupted going. It works faster, easier, safer, *longer.* It resists kinking and whipping. It is the highway to greater-dollar-value. LAY-SET Preformed both fills the bill and cuts it down. *All* Hazard wire ropes made of Improved Plow Steel are identified by the Green Strand.

BUY ACCO QUALITY *whether for Hazard Wire Ropes —American Chains (Weed Tire Chains—Welded or Weldless Chain)—Campbell Abrasive Cutting Machines—Page Chain Link Fence—Page Welding Wire—Reading-Pratt & Cady Valves—Wright Hoists or any other of the 137 ACCO Industrial Products.*

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District Offices: New York • Chicago • Philadelphia • Pittsburgh
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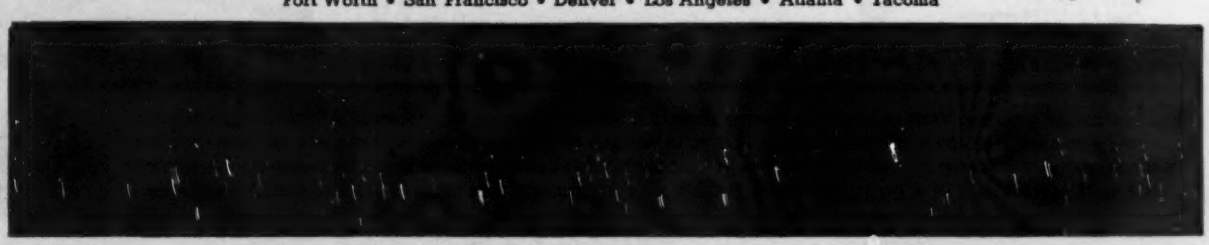
GREEN STRAND SIGNIFIES SAFETY



★ DROP FORGED STEEL ★
★ HOT GALVANIZED ★

FOR FASTENING WIRE ROPE
SAFELY

Steel cables should be fastened with Steel Clips. The Genuine CROSBY CLIP matches your fine steel cables in quality and its perfect gripping design insures safety.

Hot galvanized — will not rust. Made since 1883 by the

AMERICAN HOIST & DERRICK CO.
ST. PAUL, MINN.
CHICAGO NEW YORK

For Every Water-Raising Job

Peerless Propeller Pumps. Up to 100,000 g.p.m. from low and medium lifts. New airfoil design attains high efficiency.

Peerless Hi-Lift Pumps. Up to 90 g.p.m. at high pressure from small diameter wells at slow shaft speeds. Utilizes new principle.

Peerless Turbine Pumps. Up to 10,000 g.p.m. Made in three types: Belturbo, Gearturbo and Moturbo, standard of the industry.

In any service Peerless Pumps are demonstrably better. Ask any Peerless owner.

Factories:
LOS ANGELES, CALIF., SAN JOSE, CALIF.
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★ WATER OR OIL LUBRICATION
Peerless
TURBINE PUMPS
FOOD MACHINERY CORPORATION
PERFORMANCE WITH ECONOMY

ABSTRACTS AND NOTES

Atmospheric Pollution Varies Widely in Chicago

Sulphur dioxide pollution of the air in the Loop or business district of Chicago ranges from 0.22 to 0.43 p.p.m., and approximately 50 per cent of this originates in or near the Loop. Residential districts on the south side between 22nd and 63rd Sts. had almost equal pollutions, but similar districts on the north, northwest and far south had the lowest concentrations. These were the main findings of a survey to determine the presence of noxious gases resulting from the combustion of sulphur in coal. The investigation was undertaken by the Engineering Experiment Station of the University of Illinois, in cooperation with the city's smoke inspection and abatement department, and the results are presented by A. D. Singh in Circular No. 36 of the Experiment Station.

Low chimneys, domestic and industrial, contributed the major portion of the pollution. Industrial plants are serious contributors only on foggy days or in gusty winds. At railroad stations, concentrations of 1 to 3 p.p.m. were found. In outlying manufacturing districts steel mills gave only 0.05 p.p.m., although tests on the leeward side of some industrial plants indicated 0.8 to 1.46 p.p.m. Air-conditioning plants reduced the concentration in some office buildings.

• • •

Removable Paving For Grade Crossings

A new style of paving for grade crossings, now being tried on the German government railways, is designed to reduce the cost of surfacing or repairing track in the paved crossing. As described in the *Railway Gazette* (London), the paving is built into a framework which is made in sections provided with rollers, so that they can be slid along the track when the rollers are released or unlocked. In this way, one or more sections can be removed readily to expose the track construction, while highway traffic continues to use the sections still in place. Similar unit construction is employed in this country but without the rollers.

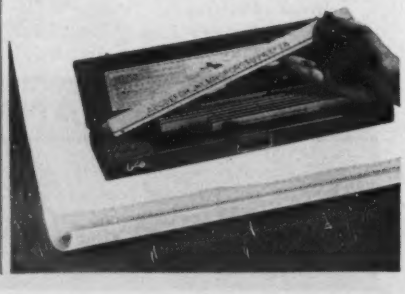
Perfect lettering with speed and ease —this is the advantage Leroy offers the modern draftsman. The precision and uniformity of Leroy lettering lends distinction to your drawings. The ease with which it is applied removes a tedious detail from drafting routine.

For Leroy lettering is simplicity itself: Choose a template from your Leroy set . . . follow the engraved characters with a pressureless stroke of the scriber . . . and the pen forms perfect lettering, directly in ink, exactly where you want it. No guide lines, no "roughing in" in pencil.

Complete letters are formed without shifting the template. All work is performed well above the guide—there is no danger of smearing when the template is moved.

You'll want to own a Leroy set. There are templates and pens of all sizes, sold singly or in sets. Ask your K & E dealer, or write for the complete new booklet.

K & E LEROY
REG. U.S. PAT. OFF.
LETTERING SETS



hemistry answers the Draftsman's Challenge . . .

This new synthetic solid gives you a permanent tracing paper

MINERAL OIL. Most tracing papers are treated with some kind of oil. Mineral oil is physically unstable—it tends to "drift" and never dries completely. Papers treated with mineral oil pick up dust, lose transparency with age.

VEGETABLE OIL. Vegetable oil is chemically unstable—it oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

ALBANITE is a crystal-clear synthetic solid, free from oil and wax, physically and chemically inert. Because of this new stabilized transparentizing agent, Albanene is unaffected by harsh climates—will not oxidize, turn yellow, become brittle or lose transparency.

Here at last is a tracing paper that will stand the test of time. Albanene is made of 100% pure white rags treated with *Albanite*, a new crystal-clear synthetic solid, discovered through years of research in the K & E laboratories. It is free from Oil and Wax—chemically and physically stable. Albanene will not oxidize, turn yellow, become brittle or lose transparency with age.

You will like the working qualities of this excellent new paper. Albanene has a fine hard "tooth" that takes ink or pencil fluently and erases with ease. It is absolutely dry, does not pick up dust, helps you keep your drawings unusually clean. Because Albanene is permanent, *it will retain all of these qualities throughout the years to come.*

Try Albanene for yourself under actual working conditions. Ask your K & E dealer, or write for an illustrated brochure and a generous working sample.

EST. 1867

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REG. U. S. PAT. OFF.

THE STABILIZED TRACING PAPER

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

JUNE construction material prices continue active, with lumber, steel and cement providing the major changes. Short Leaf Yellow Pine is off 50c. and $1.00 in Atlanta and St. Louis, off $1.00 and $2.00 in Cleveland, and up 50c. to $1.50 in Dallas. Chicago Yellow Pine and Douglas Fir prices are mixed, up $1.00 on the 2x6-in., but $1.00 lower on the 1x8 and 3x12-in. sizes. Long and Short Leaf timbers are $1.50 lower in Dallas, and off $1.00 in St. Louis.

Cement is 15c. per barrel higher in Chicago, 11c. higher in Cincinnati, and up 5c. in New York, but down 5c. in Birmingham. Sand is up 15c. per cu. yd. in Chicago, and 15c. per ton in Detroit. Gravel is 25c. per ton higher in Detroit, and up 15c. per cu. yd. in Chicago.

Structural steel shapes are 40c. per cwt. lower in Atlanta, 5c. lower in Cincinnati and San Francisco, 15c. lower in Detroit and 1c. lower in Kansas City. Shapes are up 15c. in Cleveland. Reinforcing bars (new billet) are down 25c. per cwt. in Atlanta, 15c. in Seattle, and 10c. in Detroit.

New carpenters' rate in Dallas, $1.00 per hour, is 25c. lower. Structural ironworkers' rate in Baltimore is up 15c., to $1.65. Hoisting engineers new rate in Chicago is $1.70, an increase of 7½c. per hour; and in Cleveland a range from $1.50 to $1.75 supplants the former $1.50 per hour hoisting engineers' rate.

Common labor in Dallas now ranges from 40 to 50c. The previous rate was 40c. per hour.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT — Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL — Per ton, carload lots			CRUSHED STONE — Per ton, carload lots		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE — Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.75
Birmingham	2.50	2.25	2.05	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.75	2.50	2.35	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.65*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.00*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.95	1.45	1.45	1.50‡	1.50‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.10	1.10	1.10	1.10*f*	1.10*f*	....	....	6.35
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	....	1.58	....	....	1.25‡	.90‡*c*	1.00‡*c*	....	....	7.60*l*
New Orleans	2.41	2.16	....	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.65‡	2.40‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.50
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65			

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS — Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	PAVING ASPHALT — Per ton, less than 80 penetration: Tank car	Drums	ASPHALT BINDERS — FLUXES — Per gal. 80-300 penetration: Tank car	Drums	CUTBACK ASPHALT — Per ton: Tank car	Drums	ROAD OILS — Per gal.: Tank car	ASPHALT EMULSION (Quick-breaking) Per gal.: Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60*e*	$21.80*e*	$0.0675*e*	$0.0968*e*	$0.0734*he*	$0.1053*he*	$0.0583*e*	$0.0834	$0.0834
Baltimore	140.00‡	44.00‡	2.50	13.00	18.00	.05	.08	.06*h*	.09	.....	.....	.....
Birmingham	.....	25.00	.....	18.20	23.40	.0747	.1047	.0834*h*	.1134*h*	.....	.....	.....
Boston	80.00	46.50	3.00	13.00	19.00	.05	.08	.06*h*	.09*h*	.....	.09‡	.12‡
Chicago	140.00	52.00	2.60	14.00	18.00	13.00*g*	17.00*g*	.06*h*	.11*h*	.03	.08	.12
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0525	.....	.08
Cleveland	110.00	37.25	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.04	.08	.00
Dallas	.....	30.50	.....	12.00	17.00	.04	.07	13.00	18.00	.035	.05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.60*f*	19.50*f*	14.00*g*	18.40*g*	14.00	19.70	.0535	.066	.0995
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50*b*	15.00	6.50*b*	15.00*g*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	82.50	.....	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.0935	.13	.16
New Orleans	.....	.....	.....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	68.00	2.80	13.50	18.50	.055	.08	.06*h*	.09*h*	.....	.07	.10
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	115.00	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	15.00	20.00	.055	.085	.06*h*	.09*h*	.04	.08	.12
San Francisco	.....	70.00	.....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00*c*	.....	13.75	23.55	.....	25.15*g*	10.15/11.15	23.65/24.65	8.40*g*	.0575	.1308

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican *g* Per ton. *h* Per gallon.

(Continued on page 116)

Big Machine Value In These Small Shovels

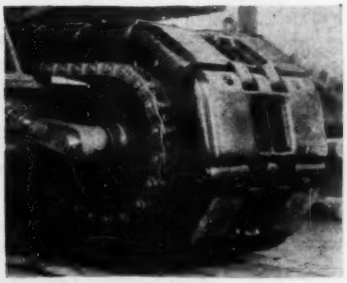
B. R. Acker Co., Inc., prominent road contractor of Takoma Park, Maryland, is but another contractor who has recently switched to BAY CITY and is experiencing new economies in excavation—getting *big machine value* from his ¾-yard shovel. The simplicity of design, accessibility, ease of operation, speed and power of these rugged machines, fully convertible without machinery change are establishing new records of performance and economy. If you want real pay-dirt at lower operating and maintenance cost, we urge you to investigate the many advantages of the BAY CITY (⅜ to 1¼ yd.), as others are doing, before buying your next shovel. Start now by writing for Catalog H-1—no obligation to learn about *Big Machine Value in Small Shovels.*

BAY CITY SHOVELS, Inc., BAY CITY, MICHIGAN

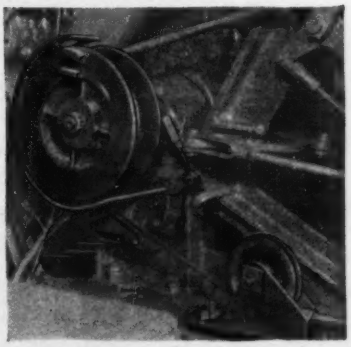
Export Office: H. M. Hein, 330 W. 42nd St., New York, U.S.A. (Oparo)

Before ordering his second BAY CITY, Mr. B. R. Acker writes *"We are more than satisfied with our new BAY CITY. It is averaging better than 100 yards an hour and operating expenses are at a minimum which means we are digging pay-dirt."*

Here are a few of the many cost reducing advantages—standard on the BAY CITY



This unique out-board bearing on crawler drive is but one of many ways in which maintenance cost is reduced in standard construction.



The simplicity of operating this instantaneous Electric Dipper Trip adds from 10 to 15% to daily yardage—there's no extra charge.

- Powerful one-piece chain crowd provides wider working ranges at lower maintenance costs—fewer delays.
- Helical gears throughout give quiet operation with greater tooth contact affording increased power.
- Unit-cast alloy steel car-body and revolving table to absorb shock and vibration—no deadweight.
- Fast, easy travel and steering under full power in either direction by simply applying pressure on cone clutches that operate brakes—no stopping to shift.

BAY CITY SHOVELS

(Continued from page 114)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ½-in. billet b	RIVETS ½-in. structural	WIRE NAILS Base d	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes c	Tie Plates c	Track Bolts
Birmingham	$2.10	$2.05	$3.40	$2.45	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.05	3.40	2.45	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.05	3.40	2.45	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.05	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.05	3.40	2.45	....	....	....	....	....	....	....	....
Youngstown	....	2.05	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.15‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45a	2.40a	....	....	2.85a	....	....	....	....	....	....	....
Pacific ports	2.70a	2.50a	....	....	2.90a	....	....	....	....	3.00	2.25	....

‡ Delivered. a F.o.b. cars dock. b For rail steel deduct 15c. from billet prices. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price 15 tons or over b New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd., carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.04	$1.94	.02½	.10	$21.00	$23.00	$1.66	$1.25	$0.1566	$3.04
Baltimore	3.35	2.70	2.55	.....	.10	21.00	23.00	1.54	1.17	.1458	2.70
Birmingham	2.10a	2.05	1.90	.02½	.10	19.50	21.50	1.64	1.23	.1548	....
Boston	3.85	2.58	2.43	$20 C.L.	.10	21.50‡	23.50‡	1.60	1.21	.1512	2.99
Chicago	2.10a	2.05	1.90	.03	.05	18.50	20.50	1.51	1.15	.1422	2.40
Cincinnati	3.83	2.31c	2.16c	.....	.05	20.50	22.50	1.50	1.14	.1413	....
Cleveland	3.58g	2.05	1.90	.02½	.10	20.50	22.50	1.50	1.14	.1422	....
Dallas	4.15	2.80	2.65	.....	.....	25.00	27.00	1.77	1.32	.1674	....
Denver	4.21	3.80	3.74	.....	.....	23.50	25.50	1.81	1.34	.1710	....
Detroit	3.65‡	2.45	2.30	.....	.10	22.50	24.50	1.52	1.16	.1440	2.66
Kansas City	4.03	2.51c	2.36c	.0	.05	18.50	20.50	1.62	1.22	.1539	2.86
Los Angeles	3.50f	2.65	2.50	.02½	.05	23.00	27.50	1.77	1.32	.1674	3.50
Minneapolis	3.80‡	2.38c	2.23c	.0	.10	21.50	24.50	1.64	1.23	.1548	2.73d
Montreal	3.25	2.65	2.55	.....	.....	26.68	29.90	2.90	2.00	.300	3.95
New Orleans	3.90	2.69	2.54	.05	.10	21.00	23.00	1.67	1.26	.1584	2.875
New York	3.75	2.29	2.14	.....	.10	20.50	22.50	1.56	1.19	.1476	2.74
Philadelphia	3.40	2.37	2.22	.....	.....	20.50	22.50	1.55	1.18	.1467	2.72
Pittsburgh	2.10a	2.05	1.90	.02½	.10	21.50	24.50	1.43	1.10	.1350	2.40
St. Louis	3.47	2.29	2.14	.0	.05	23.50	25.50	1.53	1.16	.1449	2.70
San Francisco	3.45	2.50	2.35	.02½	.10	23.50	25.50	1.77	1.32	.1674	3.00
Seattle	2.70e	2.40e	.....	.....	.....	25.50	27.50	1.77	1.32	.1674	2.90e

‡ Delivered. a Mill prices. b 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 30c.; 1 to 5 tons, add 10c.

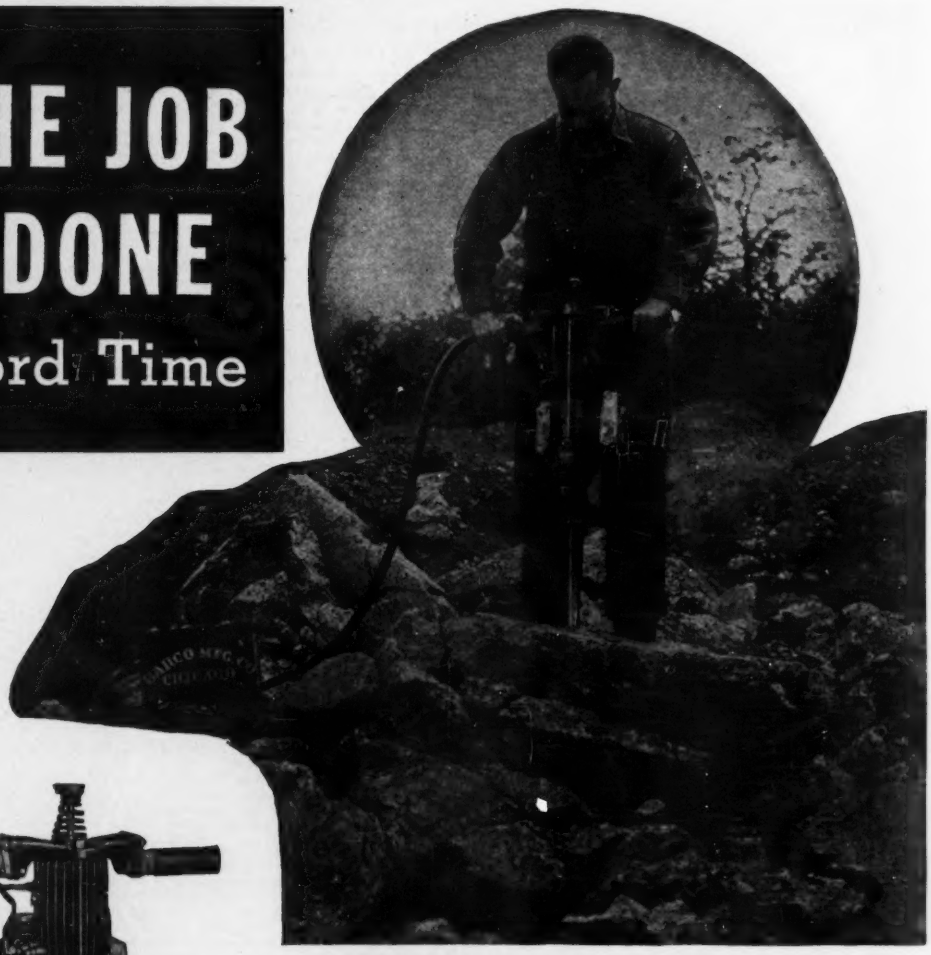
PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.a	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13-35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14-35 24 in.	WROUGHT STEEL PIPE Full standard weight, h 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$46.40	$0.26bc	$0.468bc	$1.69	$4.50c	$35.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	49.80	.30	.55	2.40	7.10	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	42.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	52.00	.245	.4725	1.98	5.535	166.50‡	240.00‡	.45	2.30	64.1	56.1	61.6	53.1
Chicago	50.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	49.70	.231	.4455	1.755	5.2275	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	51.24	.21	.405	1.575	4.8175	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	55.20	.27	.486	1.944	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	57.60	.29†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2
Detroit	51.24	.147	.2835	1.215	4.70	66.45	111.40	.25	1.125	66.3	58.3	63.8	55.3
Kansas City	52.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	52.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	54.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.59	.90	3.15	5.10e	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....
New Orleans	48.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	49.20	.32	.63	2.35	6.15	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	47.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	52.60	.182†	.351†	1.44†	4.20	97.80	154.20	.85g	2.00g	68.5i	60.5i	66.0i	57.5i
St. Louis	49.48	.26	.501	2.016	3.96	85.00	170.00	.80	2.00	65.1	57.1	62.0	53.5
San Francisco	52.00	.3275d	.5895d	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....
Seattle	52.35	.35	.63	2.52	6.30	72.00	175.00	.50f	1.40f	.....	.....	.....	.....

‡ Delivered. † F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $46.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. e 30-inch. f Less 5% for cash. g Culvert pipe. h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. i Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20.

(Continued on page 118)

ON THE JOB AND DONE
In Record Time



ONE MAN
transports it

SAME MAN
operates it

BARCO HAMMER
Arranged for Wet
Battery Operation

● Heavy on the work but light on the cost — here is a tool that warrants your investigation. Portable, compact, efficient and economical—it can be kept in a tool box on the job or stored away in the back of a car or small truck. Ready on a second's notice BARCO'S work with clock-like efficiency whether drilling, digging, driving, breaking or tamping.

The hard hitting BARCO pays for itself in record breaking time . . . performs equally well on big jobs and small, in summer or winter doing a thorough job under extreme weather conditions.

BARCO MANUFACTURING COMPANY
1815 Winnemac Ave., Chicago, Ill.

BARCO *Portable* GASOLINE HAMMER

(Continued from page 116)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

SHORT LEAF YELLOW PINE AND DOUGLAS FIR—All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)

	1x6, S1S	1x8, S1S	2x4, S1S	2x6, S1S	2x8, S1S	2x10, S1S	3x12, S2S	6x12, S2S	12x12, S2S	LONG LEAF Y. P. Merchantable grade up to 20 ft. 2x12, S2S	12x12, S2S	PLYWOOD k Rail freight increment (See note for base price) ¼"	¾"
Atlanta	$19.50	$19.50	$19.00	$20.00	$20.00	$21.00	$28.00	.....	.....	$38.50	$50.50	$17.75	$21.60
Baltimore	24.00	25.00	24.00	25.00	26.00	27.00	39.00	.....	.....	68.00	70.00	17.35g	21.15g
	31.00	*31.00*	*31.00*	*31.00*	*31.00*	*31.00*	*39.00*	*$39.00*	*$39.00*	.....	.....	.....	.....
Birmingham	19.00	19.00	19.00	19.00	19.00	20.00	30.00	30.00	30.00	.....	.....	16.25	19.85
[1]	22.00	22.00	26.00	26.00	26.00	36.00	54.00	.....	.....	48.00	53.00	.....	.....
Boston	26.00[3]	26.00[3]	30.00[3]	30.00	48.00[4]	58.00[4]	72.00[4]	.....	.....	72.00	72.00	17.35g	21.15g
	24.00	*24.00*	*28.00*	*30.00*	*32.00*	*32.00*	*35.00*	*40.00*	*40.00*	.....	.....	.....	.....
Chicago	29.00	29.00	32.00	31.00	32.00	31.00	46.00	.....	.....	75.00	85.00	13.15	16.05
	33.00	*33.00*	*35.00*	*35.00*	*34.00*	*36.00*	*40.00*	*40.00*	*40.00*	.....	.....	.....	.....
Cincinnati	23.75	23.75	25.00	23.50	24.50	26.50	37.50	.....	.....	46.00	49.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*39.50*	*39.50*	*39.50*	.....	.....	.....	.....
Cleveland f	29.00	30.00	34.00	30.00	31.00	39.00	47.00	.....	.....	50.00	60.00[3]	16.65	20.25
Dallas e	28.50	32.00	31.50	28.50	30.00	32.50	53.50	52.50	52.50	63.50	71.00	13.90	16.95
Denver ‡	41.00[4]	39.00[4]	43.00[4]	42.00[4]	42.00[4]	47.00[4]	45.00[4]	56.00[4]	64.50[4]	.....	.....	9.90	12.05
Detroit	26.00	26.00	27.00	27.00	29.00	31.00	36.00	.....	.....	31.00	43.00	16.25	19.85
	.....	.....	.....	*36.00*	*36.00*	*36.00*	*37.00*	*43.00*	*43.00*	.....	.....	.....	.....
Kansas City	27.00	28.50	28.00	26.00	28.00	30.00	35.00	.....	.....	55.00	58.00	12.25	14.95
	28.00	*28.00*	*28.00*	*28.00*	*28.00*	*29.00*	*34.00*	*35.00*	*35.00*	.....	.....	.....	.....
Los Angeles a	*35.00*	*35.00*	*35.00*	*35.00*	*36.00*	*36.00*	*42.00*	*46.00*	*49.00*	.....	.....	9.35gh	11.35gh
Minneapolis ‡b	43.00[3]	43.00[3]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*54.00*	*54.00*	*55.00*	*55.00*	*55.00*	*55.00*	*55.00*	*58.00*	*55.00*	.....	.....	.....	.....
Montreal [7]	*44.00*	*44.00*	*49.00*	*47.00*	*48.00*	*58.00*	*84.00*	.....	.....	*135.00*	*145.00*	.....	.....
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.00*	*41.00*	*40.50*	*40.00*	.....	.....	.....	.....
New Orleans	22.00	22.00	20.00	19.00	20.00	22.00	42.00	.....	.....	58.00	65.00	13.90	16.95
	26.00	*26.00*	*28.00*	*29.00*	*33.00*	*30.00*	*33.00*	.....	.....	.....	.....	.....	.....
New York ‡	36.00	37.00	35.00	36.00	36.00	37.00	42.00	.....	.....	77.50	80.00	17.35g	21.15g
‡	.....	.....	*40.00*	*40.00*	*40.00*	*40.00*	*40.00*	*42.50*	*42.50*	.....	.....	.....	.....
Philadelphia	23.50	24.00	25.00	25.00	26.00	26.50	28.50	.....	.....	54.00	56.00	17.35g	21.15g
	34.00	*36.50*	*38.00*	*37.25*	*36.50*	*36.50*	*41.75*	*51.50*	*51.50*	.....	.....	.....	.....
Pittsburgh	38.10	39.90	47.65	42.00	45.65	46.90	59.70	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis ‡c	30.00	31.50	30.00	29.00	30.00	31.00	47.00	*51.00*	*51.00*	72.00	71.00	13.90	16.95
San Francisco d	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*23.00*	*23.00*	*23.00*	.....	.....	7.30g	8.90g
Seattle	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*25.00*	*25.00*	*25.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, car load lots, delivered per 1000 sq. ft. surface. Base price — Seattle: ¼", $70.00. ¾", $77.96. For other centers add rail freight increment from table for proper size. Add: for form oil treatment, $2.50 per M. sq. ft.; for mineral paint sealed edges, $1.00 per M; for resin dipped treatment, $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum. *k* Beginning June 15, Seattle base price on ¼" will be $74.00, ¾" will be $81.50; new price includes oiling and sealing charges.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS Discounts from jobbers list, Sept. 15, 1928 Single or Double Thickness A quality	B quality	EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	88%d	88%d	$0.14
Baltimore	83%d	82%d	.15
Birmingham	89%	90%	.105
Boston	82%d	82%d	.15
Chicago	79%d	79%d	.15
Cincinnati	79–10%d	79–10%d	.15
Cleveland	85–10%	85–10%	.19
Dallas	80%d	80%d	.165
Denver	76%d	76%d	.15e
Detroit	79–10%d	79–10%d	.15
Kansas City	78–10%d	79–10%d	.155
Los Angeles	88%a	90%a	.1575
Minneapolis	76%d	76%d	.155
Montreal	70–10%b		.17†
New Orleans	80%d	80%d‖	.16
New York	82%d	83%d	.20f
Philadelphia	89–10%	90–10%	.15
Pittsburgh	79%a	79%a	.1425
St. Louis	79–10%d	79–10%d	.155
San Francisco	78%d	83%d	.155
Seattle	85%	88%	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 15, 1938 *b* Also less 6% tax exemption. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.115	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla	.12 –.13	.145 –.16	.165 –.18
Rocky Mtn. States	.12 –.1425	.14 –.155**	.16 –.175**
Pacific N. W. States	.1175–.13	.1475–.16	.1675–.18
Pacific S. W. States	.1150–.1275	.145 –.1525	.165 –.1725

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.432

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6' x8' x8' Untr.	6' x8' x8' Tr.	7' x 9' x8'6" Untr.	7' x 9' x8'6" Tr.
Boston	Oak	$1.10	....	$1.60	....
	Pine	1.30	$2.00a	1.95	$2.85a
New York	S. L. Sap Pine	1.05/1.15	1.90g	....	2.35g
	Mixed Oak	1.50	1.35	1.85	....
Birmingham	White Oak	.85	1.50a	1.35	1.70a
	Southern Pine	.55b	1.10ab	.70	1.30a
Chicago	Oak	....	1.65a	....	2.25a
	Southern Pine	....	1.53a	....	2.13a
Los Angeles	Douglas Fir	.64	1.38a	.90	1.80a
Philadelphia	Red Oak	1.10	....	....	2.40a
St. Louis	White Oak	.98	....	1.38	....
	Red Oak	.98	1.48a	1.38	1.95a
	Sap Pine or Cypress	.88	....	1.23	....
San Francisco	Douglas Fir	.80baf	....	....	1.85caf
Montreal	Birch or Maple	.65	1.05a	.75	1.35a

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle. *g* Dense pine.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.10

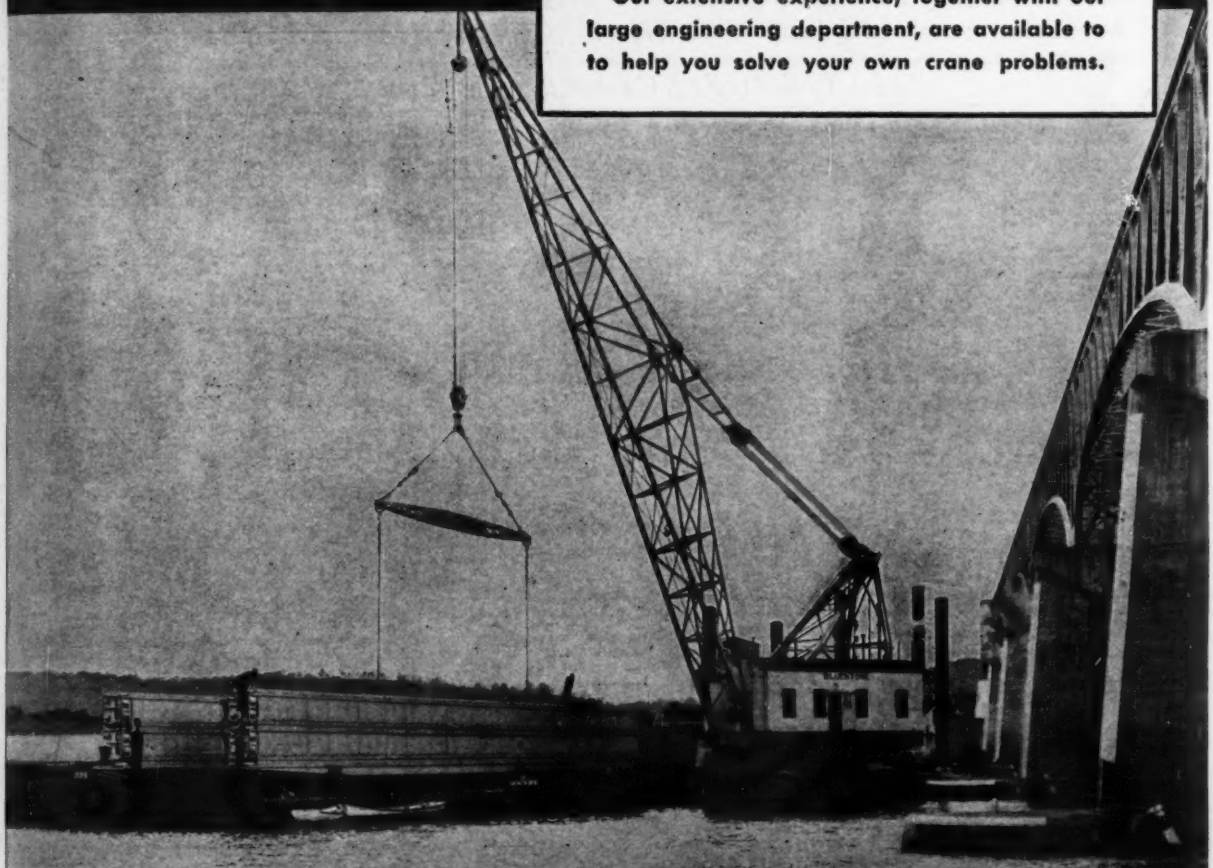
(Continued on page 120)

Floating Cranes

Due to the peculiar conditions under which they operate, the design of floating cranes differs materially from those for land service. Each crane, depending on its working conditions, presents a different problem to solve in order to insure maximum operating efficiency.

The Industrial Brownhoist floating crane shown below has a capacity of 35 tons at a radius of 117 feet and was built especially for handling lock gates on the Ohio River. It is one of many types and sizes built by Industrial Brownhoist over a period of years for use on steel pontoons, ocean going steamers, salvage barges, concrete pontoons and lake freighters.

Our extensive experience, together with our large engineering department, are available to to help you solve your own crane problems.



LOCOMOTIVE CRANES, 10 TO 200 TONS CAPACITY
CRAWLER CRANES, 6 TO 25 TONS CAPACITY
ERECTION CRANES, 10 TO 75 TONS CAPACITY
ORE AND COAL HANDLING BRIDGES
CAR DUMPERS FOR COAL AND ORE
CLAMSHELL BUCKETS

INDUSTRIAL BROWNHOIST

GENERAL OFFICES: BAY CITY, MICHIGAN

DISTRICT OFFICES

New York, Philadelphia, Pittsburgh, Cleveland, Chicago.

(Continued from page 118)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$340.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	195.00	250.00	300.00	13.00*k*	16.00*k*	18.00	14.00	2.45*m*
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00*o*	1.75*o*	2.25*lo*
Boston	90.95*ab*	96.95*ab*	181.80*ab*	206.05*ab*	276.65*ab*	316.15*a*	17.00*i*	20.00*i*	20.00	13.00	2.65*lp*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	16.80*j*	14.00*j*	2.75*jm*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	94.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	16.00	17.00	13.50	11.25	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50*fr*	89.50*fr*	128.00*cfr*	210.00*fr*	368.00*fr*	460.00*fr*	13.00	15.00	16.50	.....	17.50
Minneapolis	72.60*j*	77.50*j*	132.80	155.00	161.00*d*	225.00*d*	13.10	15.10*g*	21.00	16.00	19.00
Montreal	64.00*a*	77.00*a*	141.00*at*	77.00*a*	128.00*a*	.....	21.00	31.00	24.60	16.00	1.75*lo*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30*h*	238.80*h*	295.60*h*	14.00	.....	20.00	15.00	18.00
Philadelphia	77.40	82.50	154.50	185.70	229.90	284.60	11.00*a*	18.00*a*	15.50*q*	10.05	10.55
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.70	15.20	2.57*m*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*lm*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*a*	20.00*a*	20.00*a*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 15-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

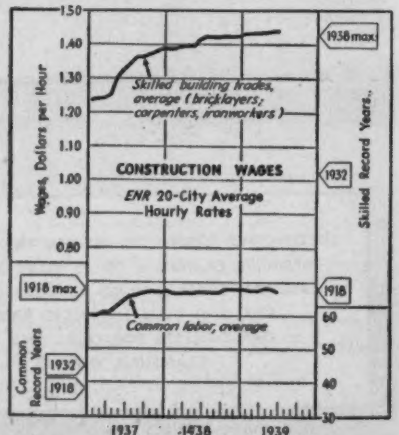
	RED LEAD Per 100 lb. in 600-lb. bbl. (Approx.) Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$8.50	$12.625	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	8.25	12.25	1.45	2.25	1.70	2.16	2.75	2.75	.49	27.50
Birmingham	8.50	12.625	2.35	2.35	1.85	2.07	2.03	2.03	.45	30.37
Boston	8.25	12.25	1.80‡	2.20‡	1.80‡	1.70‡	1.85*h*‡	1.85*h*‡	.40‡	20.00‡
Chicago	8.25	12.25	1.88	2.53	1.56	1.65*hf*	1.49*hf*	1.49*hf*	.25*f*	21.00*f*
Cincinnati	8.25	12.25	1.45	2.50	1.40	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	8.25	12.25	1.90	2.60	1.40	1.50	1.50*h*	1.50*h*	.31	21.00
Dallas	8.25	13.00	1.80	1.95	....	2.75*h*	2.50*h*	2.50*h*	.60	....
Denver	8.75	12.75	....	....	....	2.45	4.00	3.00	.35	28.00
Detroit	8.25	12.25	2.00	3.00	1.75	2.40	3.00	3.00	.35	29.00
Kansas City	8.25	12.375	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	8.50	12.75	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	8.25	12.375	....	....	....	1.50*i*	1.50*hi*	1.50*hi*	.29	21.00
Montreal	9.75	9.00	2.20	2.75	2.30	3.05	1.85	2.15	.95	10.80*k*
New York	8.25	12.25	1.80	2.45	1.48	1.50	1.50*h*	1.50*h*	.23	24.00
Philadelphia	8.25	12.25	....	....	....	1.92*e*	1.99*he*	1.99*he*	.41*e*	21.00
Pittsburgh	8.25	12.25	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	8.25	12.25	1.70/1.90	2.50/2.75	1.50/1.90	1.53	1.50	1.50	.23	21.00
San Francisco	8.50	12.50	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	8.50	12.75	1.80	3.00	2.20	1.89	1.29/1.89	2.60	.58	24.10*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* 550 lb barrel.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.375	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.00/1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.50*b*	1.50*b*	1.43*b*	....	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.45/.50
Los Angeles	1.25	1.10	1.375	1.125	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*a*	.85	.85
New Orleans	1.00	1.00	1.25	1.00	1.00	.40	.40
New York	1.880*b*	1.75*b*	1.925	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65	1.25	1.50	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.81	.65
Seattle	1.60*c*	1.25*c*	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.70	.60	.60	.55	.67	.35	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Iron workers) $1.436
ENR Common Average: $0.684